This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

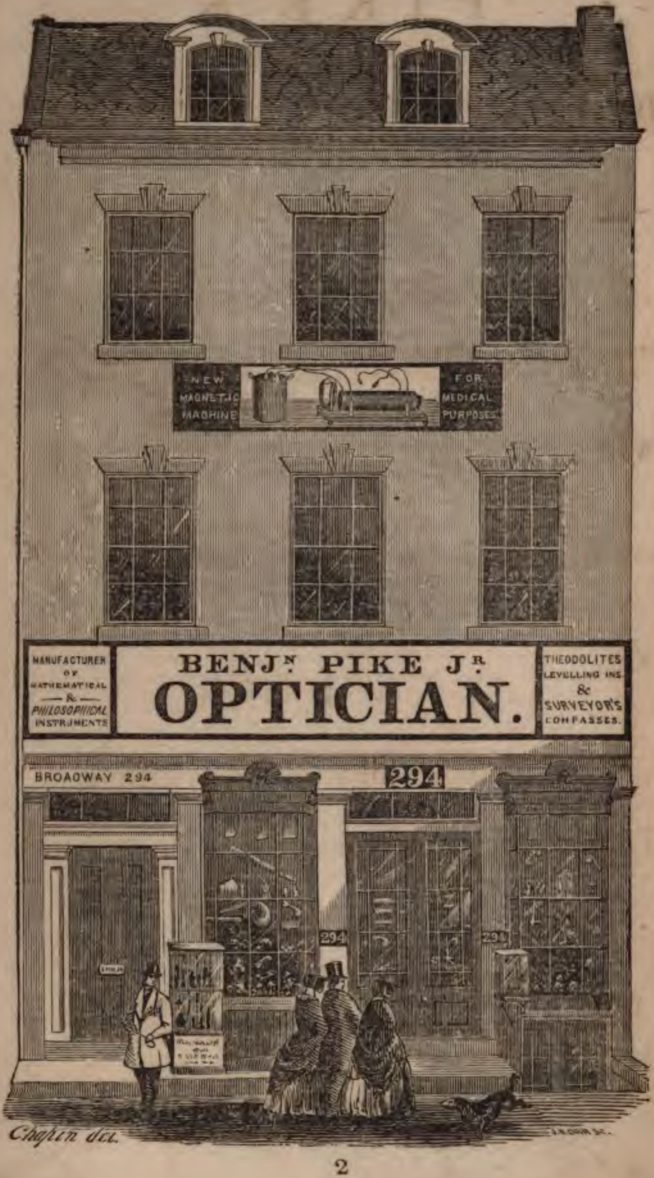
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

3 3433 06644527 5

[illegible]


NEW MAGNETIC MACHINE
FOR MEDICAL PURPOSES
MANUFACTURER OF MATHEMATICAL & PHILOSOPHICAL INSTRUMENTS
BENJN. PIKE JR.
OPTICIAN.
THEODOLITES LEVELLING INS. & SURVEYOR'S COMPASSES.
BROADWAY 294
294
294
294
Chapin del.
J.N. ORR SC.

PIKE'S
ILLUSTRATED
DESCRIPTIVE CATALOGUE
OF
OPTICAL, MATHEMATICAL,
AND
PHILOSOPHICAL INSTRUMENTS,

MANUFACTURED, IMPORTED, AND SOLD BY THE AUTHOR; WITH THE PRICES AFFIXED AT WHICH THEY ARE OFFERED IN 1848.

WITH UPWARDS OF 750 ENGRAVINGS,
MOSTLY ORIGINAL DESIGNS FROM THE INSTRUMENTS OF HIS ESTABLISHMENT
IN THE VARIOUS DEPARTMENTS OF

ELECTRICITY,
GALVANISM,
MAGNETISM,
ELECTRO-MAGNETISM,
PNEUMATICS,
HYDROSTATICS,
MECHANICS,
OPTICS,
ASTRONOMY,
SURVEYING,
NAVIGATION,
METEOROLOGY,
CHEMISTRY, &c., &c.

Designed to aid Professors of Colleges, Teachers, and others,
in the Selection and Use of Illustrative Apparatus,
in every Department of Science.

BY BENJAMIN PIKE, JR., OPTICIAN.

IN TWO VOLUMES.

VOL. II.

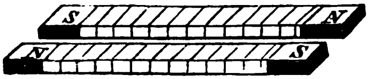
NEW YORK:
PUBLISHED AND SOLD BY THE AUTHOR,
AT HIS OPTICAL, MATHEMATICAL, AND PHILOSOPHICAL
INSTRUMENT MANUFACTORY,
294 BROADWAY,
A FEW DOORS ABOVE THE PARK.

THE NEW YORK
PUBLIC LIBRARY
343782
ASTOR, LENOX AND
TILDEN FOUNDATIONS.
1905

Entered, according to Act of Congress, in the year 1848,
By BENJAMIN PIKE, Jr.,
In the Clerk's Office of the District Court for the Southern District
of New York.

MAGNETIC INSTRUMENTS.

Fig. 409.

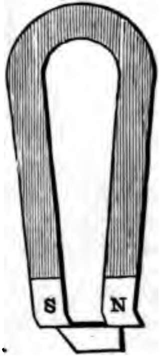


Bar Magnets.—(Fig. 409.)—These instruments are adapted for the experimental elucidation of that peculiar property conferred on bodies essentially composed of iron, whereby, under certain circumstances, they acquire the powers of polarity, attraction of unmagnetic iron, attraction and repulsion of magnetic iron, and the influence of inducing magnetism in other iron not previously magnetic.

Price, 4 inch, 25cts.; 6 inch, 38cts.
" 8 " $0.50 and $0.75.
" 10 " $0.75 " $1.00.
" 12 " $1.00 " $1.50.

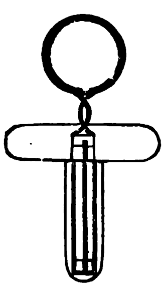
Artificial Magnets (Fig. 410) made of steel, are now generally used in preference to the natural magnet, or loadstone, not only as they may be procured with greater ease, but because they are far superior to the natural magnet in strength, and communicate the magnetic virtue more powerfully, and may be varied in their form more easily; the most usual of which is the bar magnet, and the horse-shoe or U magnet; the latter is much the most powerful. The piece of iron used to connect the poles, or extremities of a horse-shoe magnet, is the armature or keeper, and by being kept on the poles of the magnet when *not in use*, preserves its power.

Fig. 410.



ELECTRO-MAGNETIC INSTRUMENTS.

Fig. 421.

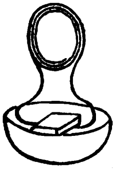


De La Rive's Ring—(Fig. 421.)—This consists of a glass cylindrical vessel, having a cork float attached to its upper end; into this vessel is inserted a small voltaic combination, consisting of a plate of zinc surrounded by a plate of copper; the zinc plate being insulated from the copper. A copper wire attached to both these plates is made into the form of a ring, consisting of several coils of the wire, which is insulated by being wrapped around with thread. Upon pouring dilute sulphuric acid into the vessels, and placing the plates in it, voltaic action commences, and is manifested by placing the apparatus afloat in water, when the coil will have a tendency to take a position in the plane of the magnetic meridian, and will exhibit all the effects of the attractive and repulsive tendencies described, when a strong magnet is brought near it on either side. If the pole be presented to it on the side where attraction takes place, the ring will move towards it till it arrives at the pole, and then proceed onwards in the same course, the magnet being held in the axis of the ring, till it reaches the middle of the magnet; but there it seems inclined to stop; and then, after a few oscillations, it settles as in a position of equilibrium; for if purposely displaced by bringing it forwards towards the other pole, it returns with a force which shows that it is repelled from that other pole. Let us now withdraw the magnet, and turning it half round, so that its poles are in

directions the reverse of what they were at first, and holding the ring in one hand, let us again introduce the magnet into it with the other hand, until it is half-way through; the slightest change in this position causes it to move with an accelerated velocity towards that pole which is nearest to it; and getting entirely clear of the magnet, it is projected to a considerable distance from it. At length, however, it stops, and, gradually turning round, presents the opposite face to the magnet; attraction now takes place, and the ring returns to the magnet with a force equal to that with which it had before fled from it; and passing again over its pole, finally rests in its position of equilibrium, encircling the middle, or what may be termed the equator of the magnet. In the former position it was equally attracted by the two poles of the magnet: in the latter it is equally repelled.

Price, $1.00.

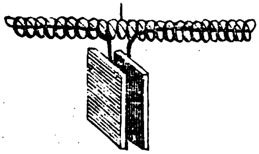
Fig. 422.



Improved form of De la Rive's Ring.—(Fig. 422.)—Another and preferable form of the same instrument, in which the motions are less impeded, consists in its being set afloat in a little glass bowl, and the voltaic pair placed in a horizontal position; the whole is then set afloat in a large basin of water, and on pouring a little dilute sulphuric acid into the bowl, the coil will be surprisingly sensible to the influence of a magnet, and will be attracted and repelled at a distance of several inches.

Price, $1.25.

Fig. 423.

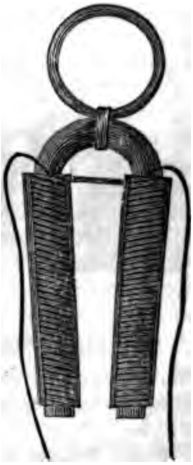


Floating Coil.—(Fig. 423.)—A simple galvanic apparatus, which when placed in acidulated water turns spontaneously, so as to place itself north or south, or accordant to the magnetic meridian. It consists of a coil of wire, the ends of which are brought through the coil, and are terminated by two pieces of metal, about an inch square each; one plate being of zinc, the other of copper. When this instrument is in use, it is necessary to suspend it by a thread, or support it by a cork at each end, lest it should sink. Price. $1.00.

Electro-Magnet.—(Fig. 424.) — This consists of a piece of soft iron bent in a U form, and surmounted with a coil, or succession of coils of insulated copper wire, the ends of which are connected with a voltaic series. Attached to the faces of the magnet is a piece of iron called the lifter, having a hook or ring for suspending any weight.

Price, three sizes, $1.00, $1.50, and $2.50.

Fig. 424.



Large Electro-Magnet.—(Fig. 425.)—This cut represents one of the most elegant modes of mounting large electro-magnets. The magnet is mounted, poles upward, on a firm and substantial base, having a pillar with an arm, or lever, passing through a mortice on the top of it; the lever being attached to the lifter over the poles of the magnet, the coils on the electro-magnet are attached by their ends to the screw cups on the base, or conveniently connecting with the battery.

Price, $20.00 to $40.00.

Fig. 425.

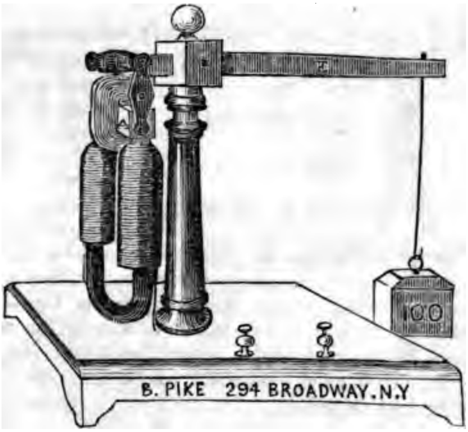
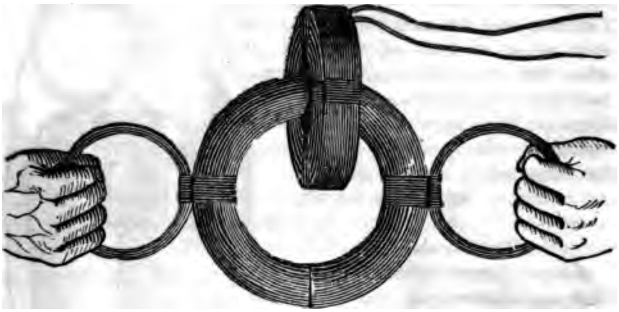


Fig. 426.

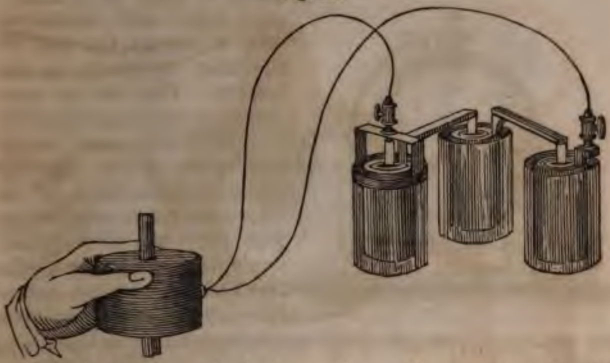


The Magic Circle.—(Fig. 426.)—This consists of a coil of coarse insulated copper wire, through which is placed two semicircular pieces of soft iron, the faces accurately fitted to each other, and when together forming a ring; to each portion there is attached a handle for holding by. On connecting the ends of the coil with the poles of a galvanic battery, the ring being placed within the coil, the two parts are held firmly together, although there may be no contact between the coil and the ring, and requiring considerable force to separate those of the best make with ball and socket handles, resisting the power of two men to separate.

Price, with ring handles, $1.00, $1.50, $1.75.
" " " $2.50.
" with ball and socket handles, $7.00.

Iron Rod supported in the Air within a Wire Helix.—(Fig. 427, next page.)—This apparatus consists of a helix, or coil of coarse insulated copper wire, of about two or three inches in length, and about the same diameter, having an aperture in the centre of the coil of about one-third or one-half of an inch in diameter, the terminations of the wire being arranged for connecting with the cups of a galvanic battery. A rod of soft iron of about three times the length, and somewhat smaller than the interior of the helix, to allow it to pass through with perfect freedom, is placed within it. If now the connexions are made with a powerful battery, the rod will be supported within the coil, resisting considerable effort to displace it, and when forced out of its position bounding back to its former place.

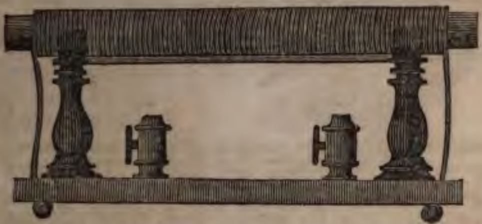
Fig. 427.



The battery required to perform this experiment with advantage should be of a power not less than three of "Grove's series," of the usual size.

Price, $1.75, $3.00, and $5.00.

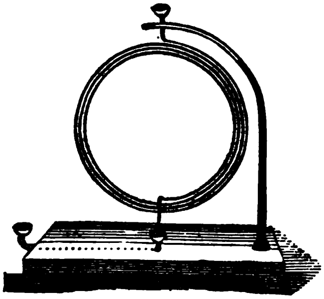
Fig. 428.



Helix on Stand.—(Fig. 428, as above.)—The helix consists of a coil of insulated copper wire, bound in the form of a close spiral spring, in one or several layers, so as to form a hollow cylinder, into which an iron rod or any body to be magnetized, is to be placed. Those having a number of layers, and the internal diameter small, have great magnetizing power. Price, $2.50 and $3.00.

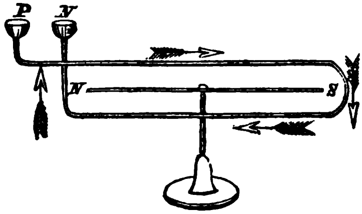
Circular Magnetic Coil—(Fig. 429, next page)—Consists of a flat coil of insulated copper wire, rolled up, for the purpose of transmitting a current of the electric fluid. One end of the coil is pointed, and mounted on a metallic centre,

Fig. 429.



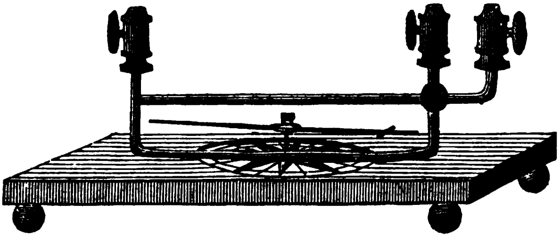
which is fixed in a mahogany base, and connected with a cap at one end of the base, by a wire on the bottom. The coil is supported at the upper part by a vertical arm, and termiates in a cup with binding screw, as also the one on the base, for connecting with the poles of the battery; on transmitting a current through the coil, polarity and magnetic attraction are produced, one side of the coil being north and the other south. Price, $2.00.

Fig. 430.



Apparatus for Oersted's Experiment.—(Fig. 430.)—This consists of a rectangular frame of brass, supporting three cups with binding screws, in such a manner that a current may be sent above a needle suspended within the frame, or below the needle, or in both directions, according as the connexions are made; the wires P and N being insulated where they cross. A positive current passing horizontally over the needle, from north to south, has a tendency to cause the north pole to move to the east; consequently, if another current be made to pass under the wire, from south to north, the needle will be affected with twice the force that a single wire would have exerted; or, what is the same thing, a continuous wire may be bent back on itself, as in the figure, and this constitutes the simplest form of the galvanometer. The current, passing in opposite directions, above and below the needle, will conspire, in both cases, to deflect it from its natural position, and in the same direction, and to bring it into a position nearer to right angles to the plane of the wires. Price, $3.00.

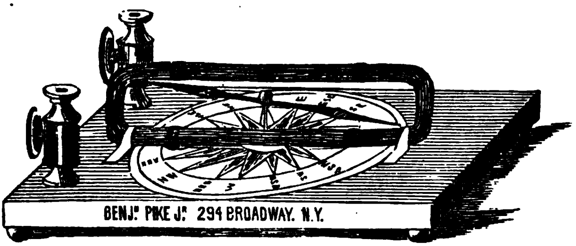
Fig. 431.



(Fig. 431, as above.)—This cut represents the same instrument, mounted on a mahogany base, having a graduated circle for estimating the deviations of the needle.

Price, $3.50.

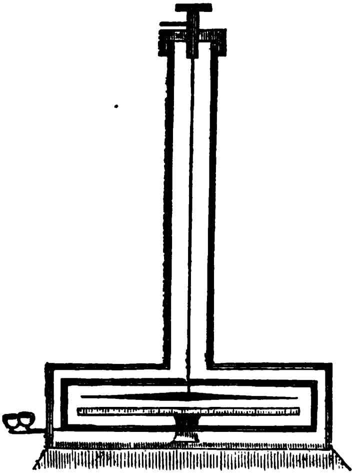
Fig. 432.


BENJ: PIKE J: 294 BROADWAY. N.Y.

Galvanometer.—One of the simplest forms of the instrument is that represented in Fig. 432, in which a common compass-needle is suspended on a pivot proceeding from a wooden stand, and enclosed by a great number of turns of wire, bent into the shape of a vertical parallelogram, and the two ends of which terminate, as usual, in small metallic cups, for the purpose of establishing connexions with any galvanic combination of which we are desirous to ascertain and measure the electrical state. A graduated circle, having a dark line across it, coinciding with the plane of the wires, is fixed to the pivot, immediately under the needle, to estimate its deviations in either direction from that plane.

Price $3.50.

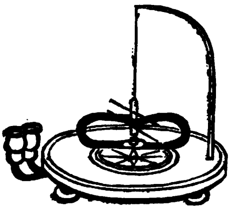
Fig. 433.



Galvanometer.—(Fig. 433.)—Greater mobility may be given to the needle by the more delicate mode of suspension employed in the balance of torsion. With this view, it may be suspended at its centre by a fine thread, or, what is best of all, by a single filament of silk, enclosed in a tube, and attached to the lower end of a short metallic wire, passed through the cover which crosses the top of the tube, and capable of being turned in the aperture with some degree of friction, so as to bring the needle to any required horizontal position. The angular turning requisite for this purpose is marked by an index fixed upon the upper end of the wire, by reference to a small graduated circle immediately below it, in the upper side of the cover. All these parts are represented in the vertical section. The other parts of the apparatus, as far as relates to the coils of wire which encircle the needle, are similar to those of the former instrument: excepting that the wires in the middle of the upper part of the coil are separated a little, in order to leave an opening for the free passage of the thread that supports the needle. A graduated circle, equal in diameter to the length of the needle, is placed immediately below the needle. The compass, wire, and card, are enclosed in glass in order to secure them from the agitations of the air, and to allow of our seeing the position of the needle.

Price, $8.00.

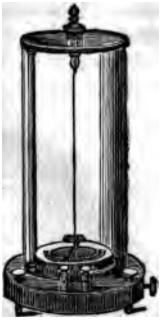
Fig. 434.



Galvanometer, with Astatic Needle.—This figure (Fig. 434) represents a simple arrangement of the galva-

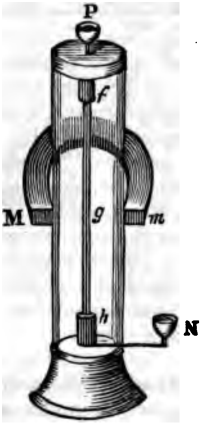
nometer, with astatic needle, which will be readily understood by a reference to those already described.
Price, $6.00

Fig. 435.



Improved Galvanometer, with Astatic Needle.—(Fig. 435.)—In this cut is represented an instrument similar to the last, with delicate and elegant adjustments, forming a galvanic multiplier, the sensibility of which may be illustrated by making with it the following experiment: Twist a piece of iron or zinc wire round one of the binding screws, connected with one extremity of the coil; place on the top of the other binding screw a drop of spring water, into which dip the other end of the wire, the needles will immediately be moved by the weak current thus set in motion. Price, $15.00.

Fig. 436



Gold Leaf Galvanoscope.—(Fig. 436.)—The construction of this instrument is similar to that of Bennet's electrometer, excepting that the leaf is single, and there is added a forceps to retain the lower end of the gold leaf, and complete the galvanic circuit. The slip of gold leaf, *g*, is suspended loosely from the forceps, *f*, while the lower end is laid hold of by another forceps *h ;* each forceps terminating in a cup, the one, P, being above, and the other, N, below, for establishing the communications by which the current is transmitted through the gold leaf. The whole is enclosed in a cylindrical glass case, the middle of which is placed between the poles of a strong horseshoe magnet, M, *m*, so that the gold leaf may be nearly equidistant from them. When the circuit is completed through the gold leaf, the latter will be attracted or repelled laterally by the poles of the magnet, according as the current is ascending or descending; the broad surface of the leaf becoming convex towards the magnet in the one case, and concave in the other. The curvature of the gold leaf may be viewed in a direction at right angles to the line of its motion, and may be referred to a fine line drawn upon the tube in the direction of its axis. This instrument is a most delicate test of the existence and direction of a weak galvanic current.

Price, with magnet, $5.00.

Fig. 437.

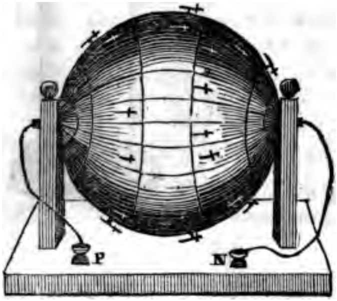
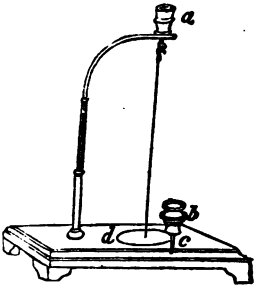


Fig. 438.

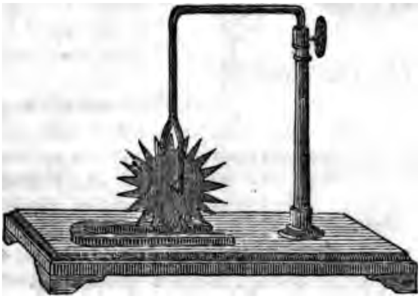


Barlow's Electro-Magnetic Globe (Fig. 437) is a globe of wood or pasteboard, supported upon two wooden uprights. The globe has a wire, covered with silk or cotton, coiled completely over it, from one pole round and round to the opposite pole. One end dips into the cup, P; the other into the cup, N. When the two poles or ions of a galvanic battery are connected with the wires in P and N, the fluid circulates around the globe, in consequence of which the globe becomes magnetic, though there is no iron attached to it; and a small delicately-balanced magnet placed upon any part of it will indicate the polarity and dip, in exactly the same manner as the usual magnet does upon the earth itself. Price, $3.00.

Marsh's Vibrating Wire.—(Fig. 438.)—This arrangement consists of a mahogany base, supporting a brass pillar bent over at the top, and having a screw cup entering the end, in the top of which mercury may be put; in the base is a trough for mercury, and a mercury cup at the side, supported by a wire connected with the trough; to the end of the screw cup at the top there is a slender wire suspended from a loop, and capable of free motion; its lower end is amalgamated, and dips into a small cistern of mercury; the cups, *a* and *b*, are filled also with mercury, and through them the electrical current is passed down the loose wire; no motion of this wire is perceptible, until a horse-shoe magnet is placed in a horizontal position, on the basis, with its poles enclosing the wire, when it is instantly urged either forwards, towards *c*, or backwards, towards *d*, according to the position of the poles, and the direction of the current. In either case it is thrown out of the mercury, and the circuit being thus broken, the effect ceases, until the wire falls back again by its own weight, into the mercury; when the current being re-established, the same influence is again exerted, the phenomenon is repeated, and the wire exhibits a quick succession of vibratory motions.

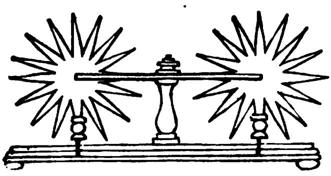
Price, $2.00.

Fig. 439.



Barlow's Spur Wheel.—(Fig. 439.)—This instrument is mounted on a mahogany base, having a small trough for mercury, and supporting a small brass figure, to which an arm is attached, branching off and bending downwards, being divided at its extremities into two branches, between which a spur-wheel, having a number of rays, is made to revolve in two centres. A horse-shoe magnet is laid on the base, with its poles inclosing the spur-wheel. One of the poles of the battery is to be connected with the mercury in the trough, and the other to the arm supporting the wheel, or with mercury cups attached to these parts for the purpose. The wheel, being constructed so as to turn round freely, will revolve with great rapidity as soon as the contacts are made with the battery; for this purpose, however, the wheel must dip so far into the mercury as that each of the rays shall touch the surface before the preceding ray has quitted the mercury. The direction of the motion depends, of course, on the same circumstances as were before mentioned. Mr. Barlow observes, however, that in general the experiment succeeds best when the wheel revolves inwards.

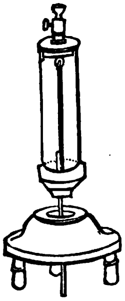
Fig. 440.



This instrument is also constructed with two wheels, as represented in Fig. 440. An electro-magnet is sometimes substituted for the steel magnet, being included in the circuit with the wheel, the current flowing through both. Changing the direction of the current in this arrangement, changes the direction of the rotation.

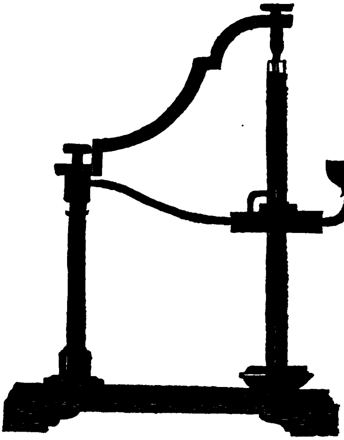
Price, - - - - - -	$2.50.
" with two wheels, - - -	$4.00.
" " " " and electro-magnet,	$5.50.
" " one " " " "	$3.50.

Fig. 441.



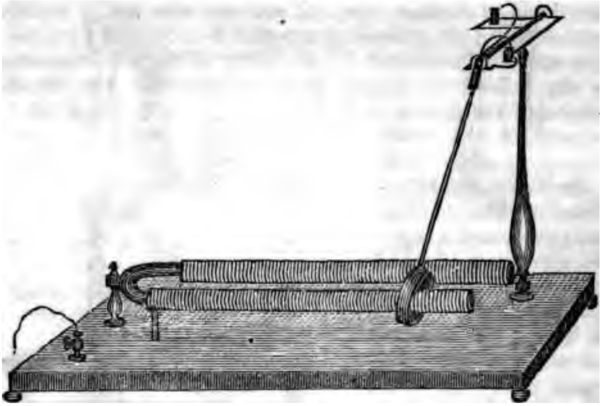
A Wire revolving round a Magnet.—(Fig. 441.)—This apparatus consists of a glass cylinder having at the lower end a cup of wood, through which a small rod of iron is fastened, projecting through for a short distance into the glass tube, and surrounded with mercury. The other end of the iron rod is inserted in a wood base, having four short pillars, beneath which a magnet may be placed in contact with the iron rod, inducing magnetism therein. On the top of the cylinder is a brass cup, having a screw cup through which a piece of platinum wire passes, and terminates below by a loop; another piece of wire hangs from this by a loop, and its lower end, which dips a very little way into the mercury; being amalgamated, it is preserved from adhering either to the iron wire or to the glass. When even a feeble voltaic combination is connected with the upper and lower ends of this apparatus, and the pole of a magnet is placed in contact with the external end of the iron wire, the movable wire within rapidly rotates round the temporary magnet thus formed by induction at the moment, and by changing either the connexion or the pole of the magnet in contact with the iron, the direction of the motion itself is changed. Price, $3.50.

Fig. 442.



Revolving Magnet.—This instrument (Fig. 442) consists of a magnet, about seven inches long, having at each end a delicate point, on which it is supported by a mahogany stand, pillar, and arched frame-work, and turning at the bottom in a small brass cup, in which there is a well-finished centre, and at the top in a centre attached to the lower part of the screw-cap. Near the middle of the magnet there is supported, by an arm from the pillar, a stage in the form of a ring, through the centre of which the magnet passes freely, and carrying a cistern of mercury, which also surrounds the magnet without touching it. A small wire, pointed and amalgamated at its end, is fixed to the middle of the magnet immediately above the cistern, and is bent so as just to dip into the mercury contained in the cistern; a copper wire, connected with the interior of the cistern, passing through its side, and bent upwards, terminates in a cup, holding mercury, for effecting the communication with the voltaic battery by wires in the usual manner; the other pole being in contact with the cup at either the top or bottom of the magnet, and in which there is also mercury, thus forming a continuous circuit through either half of the magnet, as the wires may be arranged, and rotating with considerable velocity on its axis. Price, $5.00.

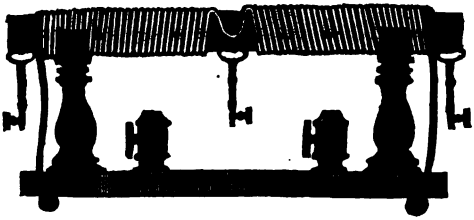
Fig. 443.



Vibrating Magic Circle.—(Fig. 443, as above.)—This instrument consists of an electro-magnet, mounted on a mahogany base, and supported in a horizontal position by a stout short pillar; the wires or terminators of the electro-magnet being soldered, beneath the base, to a cup with binding screw on the base, and the end of a long brass pillar, which pillar supports a plate at the top, and from which is suspended, by a small spindle, a coil of wire in the form of a magic circle, hanging in front of one of the poles of the electro-magnet; the ends of the coil dip into mercury cups on the top of the plate. The circuit with the battery is formed by connecting one of the poles with the cup having a binding screw, and the other with the pillar supporting the circle, causing the circle to be attracted over the pole of the magnet, by which the wires in the mercury cup are drawn out and the contact broken, the coil falling back; when the wires again dipping in the mercury, the contact is renewed, and thus a constant vibrating of a circle over the pole of the magnet takes place. Price, $6.00

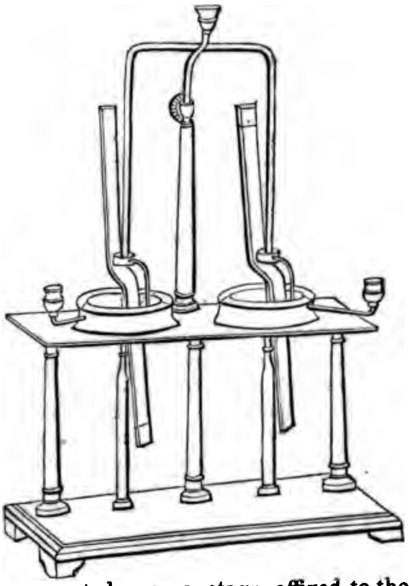
Electro-Magnet with Three Poles.—(Fig. 444, next page.)—This consists of an iron rod, wound with insulated copper wire; the wire being wound in one direction through one half of the rod, and then turning and being wound in the contrary direction; the extremities of the wires being connected with cups having binding screws on the base of the

Fig. 444.



instrument. On passing the battery current through the coil, the ends become similar poles, and the middle an opposite pole. And by changing the direction of the current the poles will be reversed. Price, $3.00.

Fig. 445.



Magnets revolving round a Wire.—(Fig. 445.)—This consists of two flat bar magnets, doubly bent in the middle, and having at the under part of the bend agate cups fixed, by which they are supported upon upright pointed wires, affixed in the basis of the apparatus, and upon which they turn round as upon an axis. Above the agate cups, on the upper part of the bend, small cisterns to hold mercury are also formed. Two circular troughs to contain mercury, are supported upon a stage, affixed to the basis, having holes in their centres to allow the magnets to pass through them. A bent pointed wire is affixed into the cisterns of each magnet, the ends of which dip into the mercury contained in the troughs upon the stage; and through the sides of the trough wires are passed, entering into the mercury contained in the troughs, and bearing at their ends other cups to hold mercury. To steady the motion of the magnets, wire loops are affixed to them, which embrace the upright pointed wires on which the magnets rest. A hollow pillar is firmly affixed to the stage, in which a bent wire supporting another cross wire is inserted, and is capable of being raised or lowered, and secured at any required height by a binding screw. The two ends of the cross wire are bent downwards and pointed, and made to enter the two small cisterns affixed upon the magnets. A third cup to contain mercury is also provided at the top of the cross wire, and a communication being made with the battery by means of uniting wires dipping into the mercury in the cups, the wire from the positive end of the battery being placed in the upper cup, and the wire from the negative end in each of the lower cups, the magnets will begin to rotate in opposite directions, and those directions may be reversed by changing the situations of the uniting wires. Two batteries should here be employed, in order to make both the magnets revolve with the desired velocity; and attention must be paid, when using two batteries, that the currents of electricity flow in the same direction; otherwise, the phenomena of the revolutions of the magnets in contrary directions will not take place, but they will both revolve in the same direction. Price, $9.00.

Ampere's Rotating Battery.—(Fig. 446, next page.)—This consists of a U formed magnet, supported on a mahogany or brass base; in the ends of each pole of the magnet there is a small hole, with a well-finished centre, and in which pointed wires are made to revolve, supporting a double cylindrical copper vessel, having a bent metal wire fixed to the top of its innermost cylinder, with a vertical wire pointed at both ends fixed in the middle of that bent wire and hung upon the upper end of each pole of the magnet, the lower points of the vertical wires of each vessel, entering the holes, formed as above described, in the magnet for that purpose. Two hollow cylinders of zinc, each furnished with similar bent wires, having holes made in the under sides of

Fig. 446.

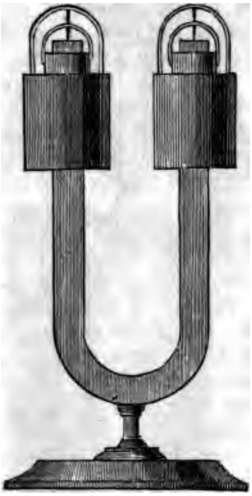
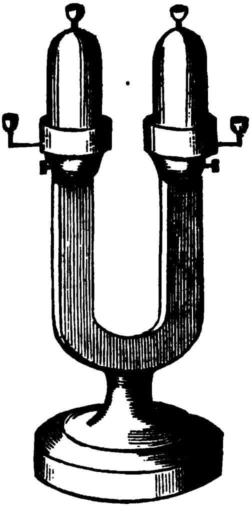


Fig. 447.



each, are then placed within the double copper vessels; the holes in the bent wires, being hung upon the uppermost pointed ends of the vertical wires, before mentioned.—Diluted acid being then poured into the space between the copper cylinders, the voltaic action commences, and presents the phenomena of the cylinders revolving upon their axes, the copper vessels revolving in opposite and contrary directions, and the zinc cylinders turning in opposite directions to them; the rapidity of their revolutions depending upon the strength of the acid, and the delicacy of their suspension.

The zinc cylinders revolve with rapidity, but from the superior weight of the copper cylinders, when filled with the exciting liquor, it is rarely that the rotatory tendency can be exhibited in them. Price, $6.00.

Revolving Cylinders.—(Fig. 447, as above.)—A horse-shoe magnet is supported vertically upon a stand, having holes formed in the centres of its ends. Two wooden circular troughs are secured by binding screws upon the arms of the magnet, to contain mercury. Into the holes in the centres of the ends of the magnet, two conical pointed wires are inserted, which are affixed in the middle of two hemispherical cups, united to cylinders, the rims of which are formed into points, which are dipped into the mercury, contained in the circular troughs. Upon the top of each hemisphere is placed a small cup, to contain mercury. Other cups for holding mercury, are supported on the external ends of bent wires, which pass through the sides of the circular troughs, into the mercury contained therein. When a stream of voltaic electricity is passed through this apparatus, by means of connecting wires, placed in the mercury, contained in the upper and lower cup, the cylinders commence revolving in opposite directions, that cylinder on the north pole, and down which the current is descending, moving of course from left to right; but if the two upper cups be united by a wire, and the lower cups connected with the positive and negative extremities of the voltaic battery, the same stream will traverse both sides of the apparatus, passing upwards in one cylinder, and downwards in the other; and the rotations will now, from the contrary influences of the two poles, be in the same direction in both cylinders. Price, $8.00.

Page's Revolving Armature.—(Fig. 448, next page.)—This consists of a U formed electro-magnet, wound with stout insulated copper wire, supported on a round mahogany base, in a vertical position, and having a brass plate soldered around the poles of the magnet, and supporting a brass pillar and arm at one end. Over the poles of the electro-magnet there revolves a soft iron armature, having a spindle supported in a centre below, and a screw in the arm above; on the spindle near the armature there is a break-piece formed of silver, by filing the opposite sides away, and against which a silver spring is fixed so as to touch the break-piece twice in each revolution, and having a wire connected with the cup, having a binding screw on the base, the terminations of the wires of the electro-magnet being with the other cup on the base, and with the iron of the magnet. On connecting the battery current with the cups on the base, the armature will revolve with great rapidity. Price, $4.00.

Revolving Wheel and Armatures.—(Fig. 449, next page.)—This consists of a wheel, having four soft iron armatures

Fig. 448.

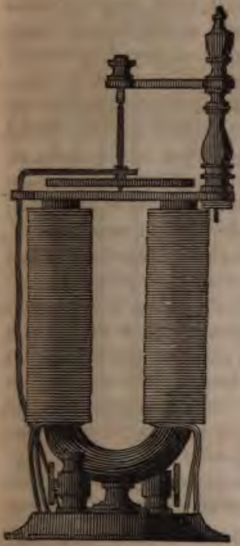
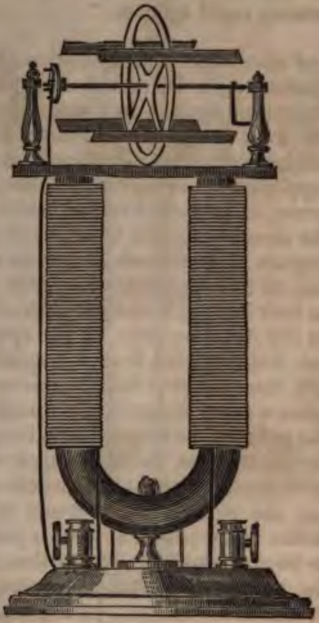


Fig. 449.



fixed on its circumference, having a spindle supported by two brass pillars and a brass plate to the poles of an electro-magnet, wound as usual, and fixed to a mahogany circular base; at one end of the spindle there is a break-piece, formed of a disc of metal, and having four silver pins projecting therefrom, their positions corresponding to those of the armatures on the wheel; against these pins there is a silver spring, touching the pins in their revolution, which is connected with one of the cups with binding screws at the base, the wires of the electro-magnet being connected with the other cup and the frame of the magnet in such a manner, that the electro-magnet will be charged on the approach of any one of the armatures, but cut off as it recedes therefrom, the current being formed by the contact of the projecting pins in the break-piece against the spring, and broken by their separation, the momentum the wheel having acquired causing the approach of the succeeding armature, thu causing rapid motion. Price, $6.00 and $7.00.

Page's Revolving Magnet.—(Fig. 450, next page.)—Thi consists of a U-formed magnet, about eight inches lon supported upright in a mahogany base; a round piece o soft iron, wound as an electro-magnet with insulated wir and having a spindle passing through its centre crosswise, an supported in a deep centre below, and above by a milled-hea screw, in an arched frame, which is soldered to the ends o the electro-magnet; the ends of the wires around the electr magnet are soldered to a Page's pole-changer, which consists of two segments of a silver cylinder, about one-third o an inch in length, and one-fifth of an inch in diameter, place on the opposite sides of the spindle above the electro-magnet, but insulated from the spindle by its being wound wit silk, the segments being separated from contact with eac other a small distance. Through the sides of the frames o the poles of the magnet, pass ivory or horn cylinders, insulating stout wires, having at their outer extremities brass cup with binding screws, and within slender silver springs pressing the cylindrical segments on opposite sides, these segments being placed in such a position as to cause the curren to be changed at a proper time to insure the revolution o the electro-magnet, by the attracting and repelling powe of the fixed magnet, joined with the like power in the revolving magnet, occasioned by the battery current flowin through the cups and silver springs, and changing every ha revolution, so that while the electro-magnet has one polarit in one half of its revolution, it has an opposite polarit in the other half. In this instrument reversing the poles o the battery in the cups will reverse the motion of the electr magnet. Price, $6.00 and $7.00.

Page's Revolving Magnet with Electro-Magnet.—(Fig 451, next page.)—By substituting an electro-magnet for th permanent magnet, a much more rapid motion may be produced, though the rotation is not reversed by the changin of the poles of the battery current, as in the permanen magnet, owing to its changing the direction of the curren in the poles of both electro-magnets; the revolutions in thi instrument are astonishingly rapid, averaging from 5 t *100,00 per minute.* Price, $6.00 and $7.00.

Fig. 450.

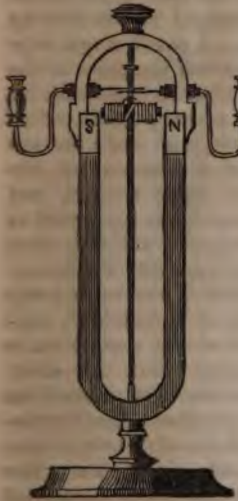


Fig. 451.

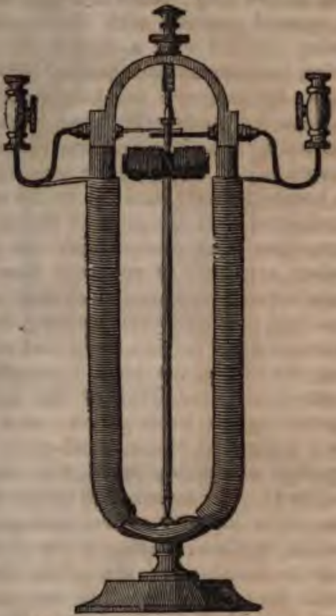
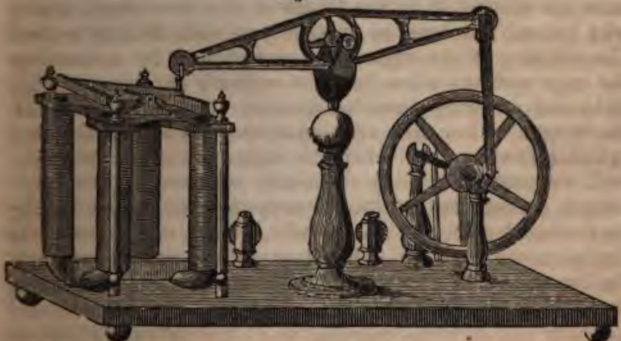


Fig. 452.

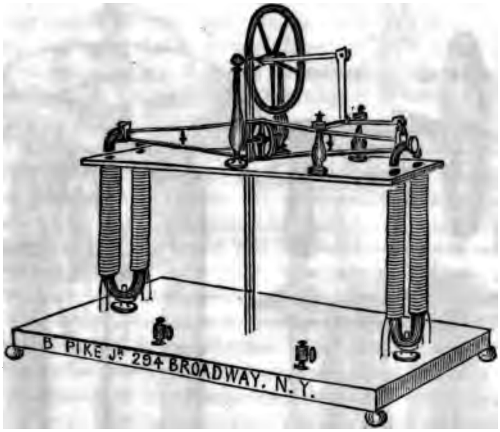


Magnetic Beam Engine.—(Fig. 452, as above.)—This cut represents a small working model of an electro-magnet motive engine, on a stout mahogany base five inches wide and ten inches long; there is supported two electro-magnets in a vertical position, with their poles upwards, the magnets being covered with a double coil of thick insulated copper wire, the terminations passing through the base to the under side; the magnets are held firmly clamped to the base by a brass bar and screw from beneath. A small stage, supported by four brass pillars, through which the poles of the magnets just extend, over which two armatures movable by a horizontal axis attached to the stage are supported, and so connected over the poles of the magnets, that, while the one armature is in contact with the poles of one magnet, the other armature is removed from the other magnet, and vice versa. The armatures thus arranged are connected to one end of a horizontal walking beam, supported on a stout vertical brass column, branched at the extremity, for receiving the axis of the beam; the other end of the beam being connected to the crank of the spindle of a fly-wheel, supported by two brass pillars; on a part of the spindle there is a compound silver break-piece, against which two silver springs alternately touch, the connexions being formed as follows:—one termination of the first electro-magnet is connected to one of the silver springs, and the other termination to the cup with binding screw at the side of the base. The one termination of the other electro-magnet is connected with the other spring, and the other extremity to the same cup with binding screw as the first is attached. The armatures are connected by the frame of the instrument, and a wire beneath the base, to another cup with binding screw. The working of the engine is accomplished by connecting the cups with the wires from the ordinary pot battery (Fig. 391), and screwing them fast therein. The battery should be charged with a fresh solution of blue vitriol, and the zinc cylinder scraped clean, when the engine will work admirably well, the armatures being alternately attracted by the magnets, in consequence of the silver springs alternately acting on the break-pieces of the spindle, giving rapid motion to the beam and fly-wheel; the silver springs must just touch the break, and be free where it is filed away, and care taken that the contact is not interrupted by dirt, &c.

Price, $12.00.

Beam Engine with Curved Armatures.—(Fig. 453, next page.)—The description given of the preceding engine,

Fig. 453.


B PIKE Jr 294 BROADWAY. N. Y.

will, in general, apply to this; the mahogany base is twelve inches long and five inches wide, the electro-magnets supported at a distance of nine inches from each other, over which a walking beam, with curved armatures attached to the ends, is made to vibrate, giving motion to a bent lever, the spindle of which is supported by two brass pillars, which again gives motion to a spindle having a crank, on which the fly-wheel is fixed; the springs and break-piece being arranged as in the preceding instrument.

Price, $18.00.

Magnetic Engine.—(Fig. 454, next page.)—In this arrangement the electro-magnets are supported on a round mahogany base, to which they are firmly clamped; four brass pillars support a circular brass plate through which the poles of the magnets pass, and over which two armatures connected together vibrate. Two pillars are screwed to the plate, over the projecting ends of two of the lower pillars which support the spindle, having the crank and fly-wheel, and to which the break piece is attached; there is a short pillar at the side of the plate supporting a bent lever, giving motion to the crank by the alternate action of the armatures; the silver springs pass from the base and press against the breakpieces alternately, as described in Fig. 452,

Fig. 454.

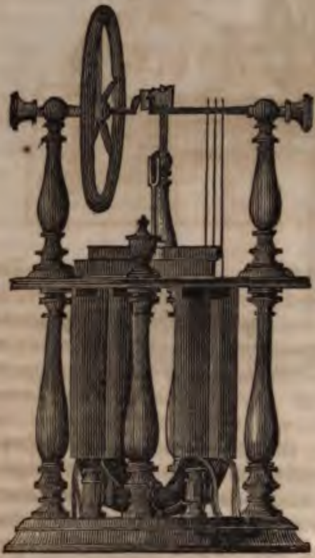
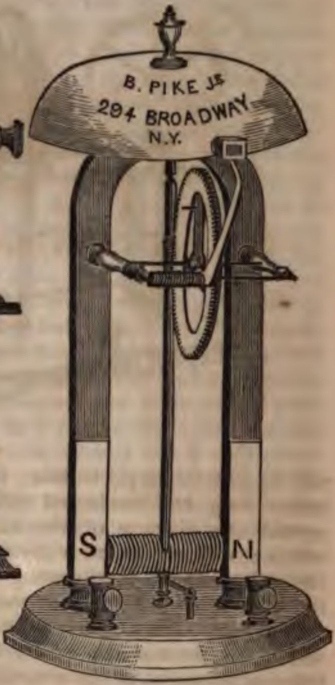


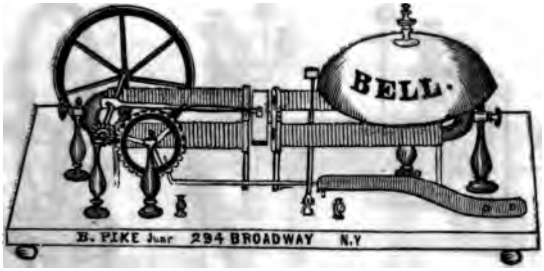
Fig. 455.



where the description given will in many particulars apply to this engine. Price, $15.00.

Bell Engine.—(Fig. 455, as above.)—This consists of a permanent magnet, of the size and construction of that decribed as Page's revolving magnet (Fig. 451); it is attached to a round mahogany base, with poles downwards, between which an electro-magnet revolves, having on its spindle an endless screw working in a toothed wheel, and supported from the sides of the magnet by an axis and two brass pillars. On the side of the wheel there is a pin projecting, which once in each revolution moves a lever attached to a hammer, which strikes the bell by being drawn back, and having a *strong* spiral spring pressing against it. Price, $12.00.

Fig. 456.


BELL·
B. PIKE Junr 294 BROADWAY N.Y

Horizontal Bell Engine.—(Fig. 456, as above.)—The horizontal bell engine is mounted on a mahogany base, 13 inches long, and 6 inches wide, having two electro-magnets, covered with stout wire, supported by brass pillars about two inches above the base, between which there is supported on two slides an armature, which is movable between the poles of the two electro-magnets; near one end of the base, two brass pillars support a spindle, having a crank, fly-wheel, and break-piece; from the crank an arm proceeds, and is connected by a joint to the top of the armature; there is also on the spindle a pinion, giving motion to a toothed wheel supported on a brass pillar; on the face of the wheel there is a pin, which in each revolution of the wheel gives motion to a lever and hammer connected, striking a bell supported on a brass pillar over the magnet at the other end of the base. The springs and connexions under the base, are arranged as in the preceding engines: the motion of this instrument is occasioned in consequence of the distribution of the current of electricity, from the galvanic battery, through the electro-magnets, by means of the silver springs and break-pieces, producing alternate attraction between the poles of the two electro-magnets, and giving motion to the arm, fly-wheel, pinion, and thus to the toothed wheel, causing the lever to strike the bell, producing rapid motion and a continual ringing, the operation of which is highly interesting. Price, $20.00.

Movable Wires for showing Attraction and Repulsion.—(Fig. 457, next page.)—This cut represents a rectangular table from which arise four upright pillars supporting two cross-pieces of wood, having a row of holes for receiving

Fig. 457.

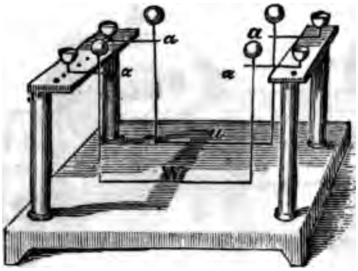
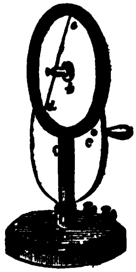


Fig. 458.

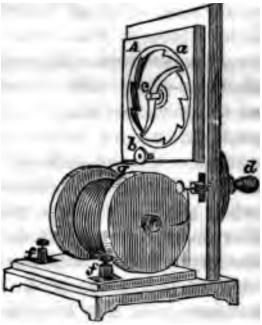


four cups, two on each piece, the distances of which from each other may by means of these holes be varied at pleasure. Short wires, *a*, *a*, *a*, *a*, proceed horizontally from the bottoms of the cups, and serve as pivots round which the two wires, *w*, *w*, bent twice at right angles, are made to turn at the upper part of their vertical branches, having small holes drilled through them for that purpose. These wires, thus hung freely upon their pivots, carry on their upper ends small weights, which, bringing the centres of gravity as nearly as possible in coincidence with the points of suspension, enable them to be moved by a very slight force. Conducting wires, proceeding from a voltaic battery, are then inserted into the cups previously filled with mercury, in such a manner that the galvanic current shall pass in the same direction through both the parallel wires; the moment this is done, the wires move towards each other, even from a distance of several inches, exhibiting a powerful mutual attraction. When the currents are transmitted in directions opposite to each other in the two wires, which they may be made to do by transposing the communicating wires inserted into the cups leading to one of the movable wires, while the others are left as before, the movable wires immediately recede from each other, manifesting a repulsion as powerful as the attraction was in the former case. Price, $5.50.

The Scintillating Circle.—(Fig. 458, as above.)—This instrument consists of a steel rim cut on the face after the manner of a file, and connected by metallic contact with one of the cups having binding screws on the base; the rim is fastened to an immovable disc, in the centre of which is a brass axis, carrying a small pulley, to which rapid rotation can be communicated by a multiplying wheel attached to the pillar. The pulley carries a steel wire, pointed at its extremities, and bent at such angles as lightly to drag over the faces of the files in rotation. The wire is removable at pleasure to admit of its adjustment or replacement. The axis is connected by a wire with the other cup on the base, which is connected with one of the terminals of a galvanic series; the other cup is also connected with the other terminal, a powerful coil being interposed between the cup on the base and the galvanic battery. On putting the apparatus in action, contact is made and broken alternately at nearly opposite diameters of the disc. The effect to the eye is a continuous circle of radiant and splendid scintillations. This is perhaps one of the most delicately beautiful of electrical experiments. Price, $8.00.

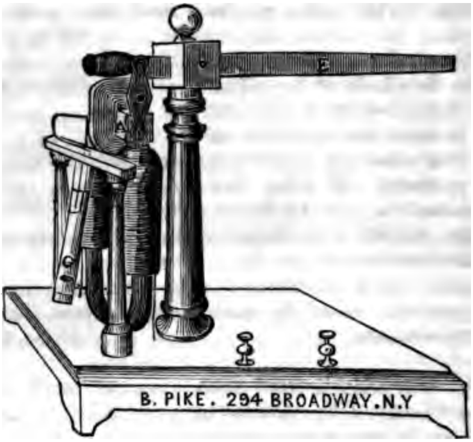
Lockey's Coil Machine, with Scintillating Circle.—(Fig. 459.)—In this cut we have a representation of Lockey's electro-magnetic coil machine, to which is attached an apparatus for producing luminous galvanic rings. The contact-breaker is the curved spring C, which is carried rapidly round by the multiplying wheel and handle, *d*, striking in its course against the notches in the interior of the metallic circle, *b*.

Fig. 459



The diameter of the ring *a b* is about five inches; they may be made of different metals, and if corresponding springs be used, there will be a different light for each. The rings are secured in the circular rabbit of the square piece of wood A, by small turn buttons; one end of the primary coil is in communication with the ring, the other is in binding screw, *e*, where one of the battery wires is to be fixed; the spring, *c*, has metallic communication with the other pole of the battery by means of its metallic socket, to which a wire is soldered and brought down to another connecting piece symmetrical with *e*, but not visible in the figure; a small portion of this wire is seen at *g*; *f*, *f*, are the usual connecting pieces from which the shock is received. Price $12,00.

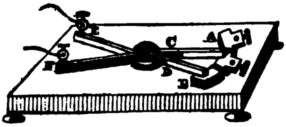
Fig. 460.



Apparatus for Detonating Gases by the Magneto-Electric Spark.—(Fig. 460, as above.)—Round the soft iron lifter of a horse-shoe magnet capable of carrying fifteen or twenty pounds, ten or twelve feet of insulated copper wire are wound. To the ends of the coil two thick copper wires are to be soldered in order to form a complete metallic circuit when the lifter is in contact with the poles of the magnet. The magnet is mounted, poles upwards, on a wood stand, having a pillar with an arm or lever passing through a mortice in the top of it, for the purpose of removing, by a sudden jerk, the lifter from the poles of the magnet. In front of the magnet a glass tube is fixed, having its top closed by a cap of box-wood, through which the copper wires soldered to the extremities of the coil pass, as near air tight as possible, into the glass tube; the end of one wire being flattened, is bent at right angles and well amalgamated. The other, which is straight, can be brought down or removed from it by means of the lever. The whole arrangement will be readily understood by a simple inspection of the figure. The mixed gases are introduced into the tube, G, by means of a bent or flexible tube. On giving the lever, E, a smart blow with the palm of the hand, the iron lifter, A, B, is suddenly removed from the poles of the magnet, a current of electricity is induced in the coil, contact between the wires in the tube, G, is broken, a spark appears, and the gases are immediately exploded.

Price, $25.00

Fig. 461.

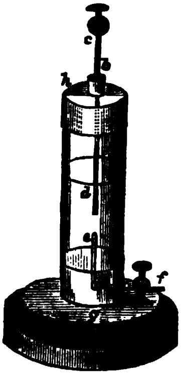


Dr. Bird's Inversor.—(Fig. 461.)—An instrument to reverse quickly the current from the galvanic battery. Its action is very simple, complete, and convenient. A B is an arc of solid brass, formed of three separate pieces, either distinct from each other, with a cavity between them; or else two pieces of ivory are inserted, that the surface at the top may be quite even. The two outer pieces of brass forming this arc are connected together by a wire underneath the stand, but the centre pillar has no connexion with the others. A, and the centre piece, have binding screws attached; C and D are two bars of brass, fixed to each other, so that when one is moved the other follows it, yet there is no metallic communication between them. There are binding screws at one end of each, while the other ends fit tightly upon the arc. The whole cross moves stiffly round the centre pin. The battery connexion being made with E and F, the object to be galvanized placed between the binding screws of the arc and the bars or cross, as represented in the cut, the positive pole being at E, the current would traverse from D to B, thence underneath by the connecting wire to A, from A through the object to the middle piece, and from this by C to F. Slipping the cross aside so that C is moved to A (other things as before), the current would pass along D to the centre piece, thence through the object to A, and back by C to F, or to the opposite end of the battery.

Price, $5.00.

The Water Regulator for modifying Galvanic Shocks.—(Fig. 462, next page.)—The water regulator, contrived by Mr. Lockey, is a useful piece of apparatus for the purpose of modifying the physiological effects of the galvanic shock obtained by the medium of the self-acting coil or other source of power. The most powerful shock can by this regulator be readily reduced to one in the mildest form. In the medical administration of galvanic electricity, this was formerly a point of some importance, as obviating the neces-

Fig. 462.



sity of any adjustment of the size of the battery, the depth to which its plates are immersed, &c.: *h* is a glass tube about five inches in length, capped at each extremity; this tube rests upon, but is not fastened to, the base, *g*, as it may sometimes be desirable to attach the regulator directly to the connector of the coil, by the wire, *f*. The fixed copper wire, *e a f*, bent to a right angle at *a*, passes out close to the bottom of the cap, and is fastened by the screw-connector, *f*. The copper connecting-wire, *c b d*, passes through a stuffing-box in the centre of the upper cap, *h* (which unscrews in order to introduce any convenient quantity of water). The apparatus is interposed in the circuit between one of the extremities of the coil and the person about to receive the shock; and, according as the points of the wire *d* and *e* are approximated to, or separated from one another, will be the strength or the gentleness of the shock. Price, $4.00.

Seebeck's Thermo-Electric Circuit.—(Fig. 463, next page.) —An instrument which shows the electric effect produced by heating dissimilar metals. It may be made of many forms. That of a parallelogram is the most usual. The two arms, A and B, are of one metal, for example, antimony; the other two arms, C and D, of a different metal, as bismuth—these are soldered at the corners. A stand supports the whole, and bears besides a small magnet, the point of suspension of which is about the centre of the parallelogram. When the heat of a flame is thrown upon either of the corners where the two metals meet, an electrical current is established, and the magnet is diverted from its polar direction, the north pole turning towards the east or west, according to the position of the two metals, that is, according to the course of the current. Price, $5,00.

Thermo-Magnetic Rectangles.—(Fig. 464, next page.)—These consist of slender wire frames, with four branches suspended on a fine point attached to the upper part of the rectangle, which is composed of pairs of dissimilar metals,

Fig. 463.

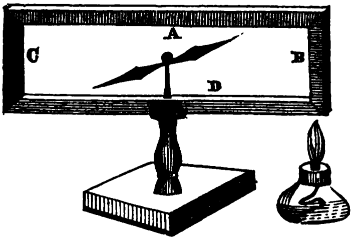
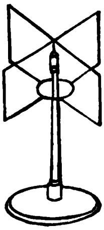


Fig. 464.



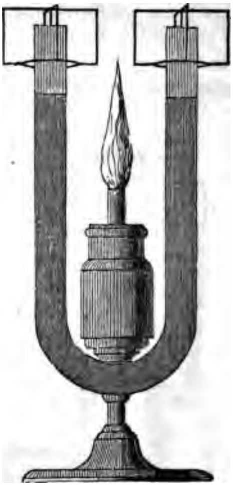
such as silver and platinum, soldered together and arranged in a rectangle, with a ring in the lower part for the introduction of a support. When the pole of a magnet is placed on one side of the frame and a spirit lamp on the other, the wire frame rotates by thermo-magnetic action.

Price, $1,75 : with stand, $2,25.

Thermo-Electric Revolving Rectangles.—(Fig. 465.)—This instrument consists of a U magnet, mounted on a brass stand, having a well finished centre in each of the poles; two rectangular frames composed of silver and platina, or silver and German silver, are delicately poised on the centres, and a spirit lamp that can be adjusted to different heights, fixed between the arms of the magnet, the flame of which causes the circulation of thermo-electric currents in the wires as evinced by their rotation round the poles of the magnet.

Price, $6.00.

Fig. 465.



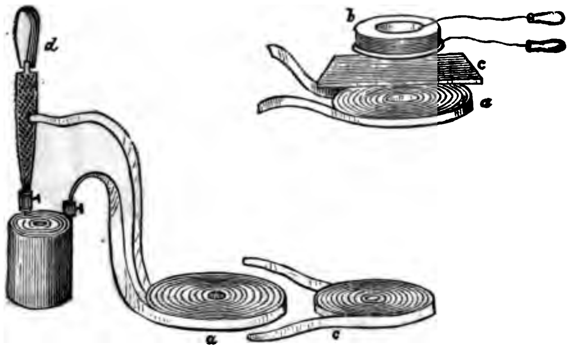
Flat Ribbon Coils.—(Fig. 466, next page.)—These consist of sheet copper, cut in strips about one inch wide, and soldered together to the length of 190 feet or more, and wound together in the form of a close spiral, each layer carefully insulated by strips of cotton.

Professor *Henry*, of Princeton, to whom we are indebted for very elaborate investigations, connected with these instruments, thus describes the manner of use: *a*, is the ribbon coil about 100 feet long; *d*, a rasp, the end of which communicates with the zinc cylinder of the battery, through the medium of a cup of mercury; one end of the ribbon is placed permanently in the cup connected with the copper element, and by drawing the other end smartly over the surface of the rasp, a series of brilliant sparks are produced, and the electrical current through the coil is rapidly broken and renewed.

Now on placing coil, *c*, containing about 100 feet of insulated copper ribbon, on coil, *a*, a plate of glass being interposed, and sending the electrical current from the battery through *a*, it was found that as often as the circuit was interrupted, a powerful secondary current was induced in *c*, and that when the ends of this coil were rubbed together, sparks were produced; when a small coil of wire enclosing a needle was interposed, the needle became magnetic; when a small horse-shoe of soft iron, surrounded by a coil of wire, was interposed, magnetism was developed; when the ends of the coil were attached to a small decomposing apparatus, gas was given off at each pole, and when the body was interposed, a shock, though a feeble one, was experienced.

Price, $4 to $8.00.

Fig. 466. Fig. 467.



Flat Wire Coils.—(Fig. 467, as above.)—These consist of fine insulated copper wire, from 1000 feet and upwards long, wound in the form of a flat spiral, and carefully cemented together in that form; used with the ribbon coil the experiments are very interesting and astonishing.

The experiments of Professor Henry, relative to the induction of secondary currents at a distance, are exceedingly striking. By sending an intermitting current of electricity through the spiral, *a*, and placing the helix of thin wire, *b*, over it, a plate of glass being interposed, shocks may be obtained on grasping the handles attached to the coil. When *a* consisted of about 300 feet of copper ribbon, one and a half inch in width, and *b*, a helix of copper wire five miles long, Dr. Henry found that shocks might be obtained when the coils were four feet apart; and at a distance of twelve inches, they were too strong to be taken through the body. The Professor also mentions a very instructive method of exhibiting these astonishing experiments, which the author has frequently adopted in the lecture room, viz. to cause the induction to take place through the partition-walls of two rooms, for which purpose a coil, about 100 feet of ribbon, is suspended against the wall in one room, while a person in the adjoining room receives the shock by grasping the handles of a helix, of about 300 yards of thin wire, and approaching it to the spot opposite to which the coil is suspended. The effect is as if by magic, without a visible cause. It is best produced through a door, or thin wooden partition. Price, $3.00 to $6.00.

MAGNETO-ELECTRIC MACHINES.

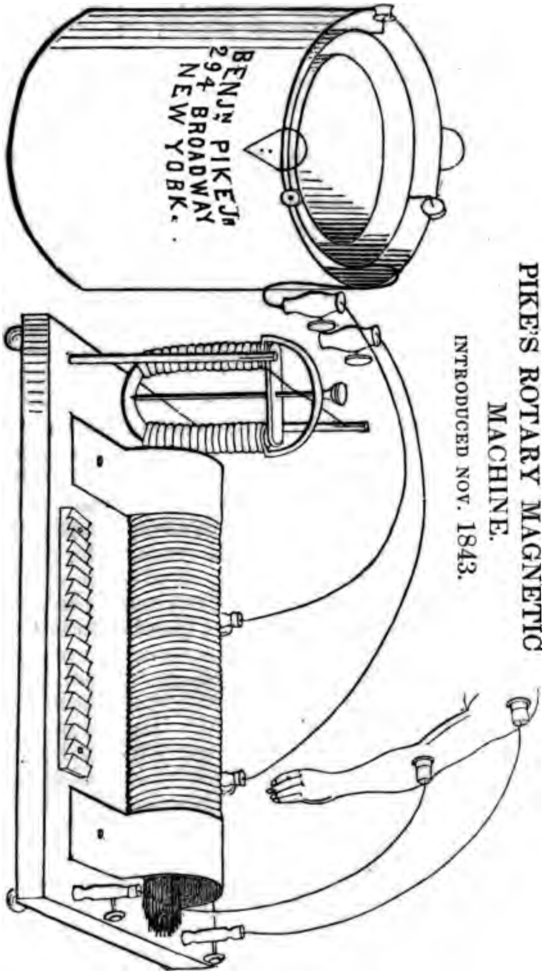
PIKE'S ROTARY MAGNETIC MACHINE.—(Fig. 468.)

Introduced November, 1843.

The favor with which these little machines have been received by many of the medical profession, and others who have used them, on persons laboring under various diseases who have been restored to health, or benefited thereby, induces this publication. The machine is entirely different from all electrical machines and galvanic batteries—it requires to be used but from five to ten minutes at a time. The effects are not repulsive to the patient, and no ill effects can be referred to. Testimonials in its favor are daily accumulating. It admits of the most perfect control, as from a high degree of power, it can be graduated with unerring certainty, down to the very smallest, by a slight alteration of the piston rod, at the pleasure of the operator. It requires no assistant in its use, where the person is able to hold the conductors.

It is used with astonishing success in cases of nervous diseases, neuralogy, paralysis, rheumatism, sick and nervous headache, dyspepsia, bronchitis, loss of voice, scrofula, curvatures of the spine, toothache, sprains, deafness, and many other diseases. The manufacturer being the improver and first introducer of the Improved Medical Magnetic Machine, and a practical magnetic instrument maker for the last twenty years, it will be his aim to furnish the very best instruments, and at prices as low as any in the market, and he can with confidence recommend the superiority of these machines over all others in use; and as there are machines made of very indifferent workmanship, and which are soon put out of order, would state for the benefit of those abroad, *and not personally* acquainted with the standing of his in-

Fig. 468.



PIKE'S ROTARY MAGNETIC MACHINE.
INTRODUCED NOV. 1843.

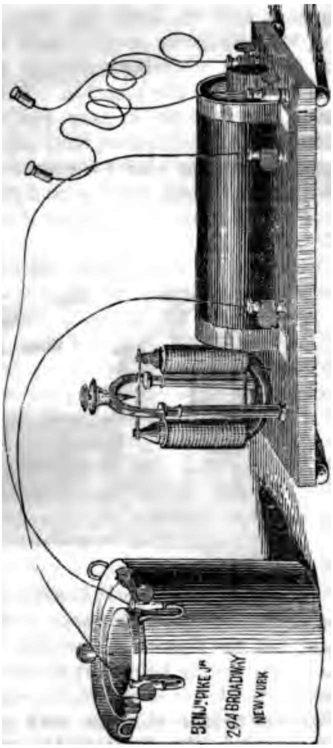
struments, that his machines have been purchased, unsolicited, and used by all the hospitals, infirmaries, and medical institutions in the city and vicinity, by nearly all our physicians, and over one thousand of our best citizens, as well as by numerous distinguished persons in various parts of this country and foreign lands. Abundant references of its efficacy can be given. Many of the cures have been pronounced astonishing.

Description and Directions.—The machine represented in the previous page consists of a double coil or helix of coarse copper wire, insulated, over which is wound about 1000 feet of very fine insulated copper wire, in the interior of which can be placed a number of soft iron wires, from one to fifty, or more, and which, when the machine is in operation, become powerful magnets, and regulate the strength of the power according to the number used. At one end of the machine is an electro-magnet, to which is attached a revolving armature, to distribute the power of the battery alternately, by means of a silver break-piece and a silver spring, and to the supports of which are soldered the wires of the two inner coils, and through which the power flows by means of the two brass cups (for the wires of the battery) at the side of the machine. The fine wires are connected with two cups at the end of the machine, and in which are secured wires communicating with handles, buttons, or balls, for receiving the effect. The cylindrical battery consists of a double cylinder of copper, with a bottom of the same metal, and a movable cylinder of zinc, with three branches to support it between the cylinders of copper. The branches are covered with wood, to insulate it from the copper. There are cups with binding screws on each, to receive the wires from the machine. The liquid employed is the sulphate of copper (blue vitriol) dissolved in boiling hot water,—about two ounces to the quart of water,—but left to cool before using. The liquid requires to be renewed when the acid is entirely taken up by the zinc, which will depend on thetime that the zinc is left in the liquid. With care, it may be made to last for 100 or more applications. The zinc cylinder should be left in the solution only while the application is made, as it soon becomes coated with a deposit, which should be scraped off with an old knife, as a clean surface of zinc is requisite to the perfect operation of the machine; the solution may remain *in the copper* any length of time, as it does not act on it.

There is a steel rasp at the side of the instrument, which is used when the greatest effect is wanted, in which case the wire from the battery that is nearest the electro-magnet is taken out of the cup and grated along the rasp, which will increase the power much, though the armature will stop revolving. The intensity of the power may be much increased by wetting the part to which it is applied with water or vinegar, and also varied by grasping or pressing the handles or conductors. The silver spring requires to be adjusted with care, and should gently touch the break-piece where it is filed away, touching twice in each revolution. If it press the break-piece too hard it will stop the armature; if it does not touch, the current cannot flow. Also keep the zinc cylinder from any contact with the copper. The machine is packed in a neat case, sixteen inches long, six inches wide, and seven inches deep, and has a pair of handles, a pair of insulated coppers, and a foot-plate with the necessary wires, and a number of papers of blue vitriol for the battery; the form of battery will keep this instrument five times as long in action as the square batteries in use, having the same quantity of blue vitriol.

Price, $14.00.

Fig. 469.

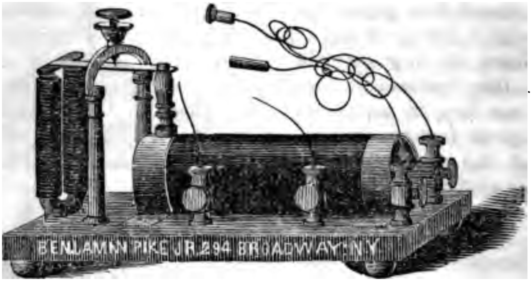


Vibrating Magnetic Instrument for Medical use.—(Fig. 469.)—In this arrangement the armature, instead of revolving, vibrates between the platina point and one of the poles of the magnet, the armature being in the *form of* a small hammer attached to a silver spring, having a platina centre on that part in contact with the point, and the end supported from one of the poles of the electro-magnet, the hammer vibrating between the other poles and the platina point. The point is supported from a milled-head screw, having a milled-head nut to tighten it, and entering the top of a brass frame, supported by two brass pillars. The screw may be turned to vary the vibrations.

The electro-magnet being charged by the battery current attracts the hammer, or armature, but the current being immediately interrupted thereby, in consequence of the separation of the platina point from the spring, the armature flies back, and the contact being removed, is again attracted and loosened, and thus a rapid vibration is carried on, the shocks succeeding each other with such rapidity, as to occasion only the sensation of numbness and powerful contraction of the muscles. This instrument is packed in a neat case with pot battery, pair of handles, pair of insulated conductors, foot-plate, and the necessary wires, with a quantity of blue vitriol wrapped in papers, each one containing the right quantity for charging the battery.

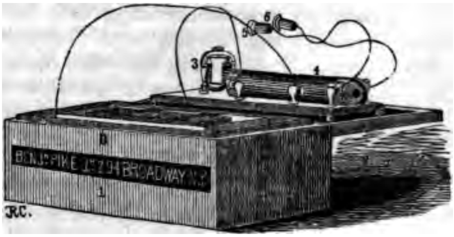
Price, $14.00; or the instrument only, $10.00.

Fig. 470.


BENJAMIN PIKE JR. 294 BROADWAY. N.Y.

Magnetic Machine Vibrating from both Poles.—(Fig. 470, as above.)—This instrument is the same as the preceding one, but the armature vibrating from both poles of the magnet; the spring being supported by a brass pillar fixed on one of the brass bands that secure the helix to the board. This instrument vibrates with great force, but the former instrument is the least liable to derangement. The wires are represented connected, the one with a handle for the hand, and the other an insulated conductor for applying to any part of the body, by taking hold of the smaller part. This instrument is packed, and has the same apparatus as the preceding ones. Price, $15.00.

Fig. 471.


6
5
3
4
2
BENJ. PIKE JR. 294 BROADWAY N.Y.
1
RC.

New Portable Magneto-Electrical Machine for Medical Purposes.—(Fig. 471, as above.)—The machine consists of a double coil or helix of coarse copper wire, insulated, over which is wound about 1000 feet of fine insulated copper wire, in the interior of which is placed a bundle of soft iron wires; and which, when the machine is in operation, become powerful magnets, and regulate the strength of the power according to the extent they are placed in. At one end of the machine (placed sometimes at the side), is an electro-magnet, formed of soft iron, and bent in the form of an U, and wound with two coils of covered copper wire, one end of which is soldered to the magnet, and the other communicated with the coarse helix. To one end, or pole, of the electro-magnet is fastened a spring with a small hammer at one end, and just over the pole of the electro-magnet, and through which spring the power of the battery flows; from the point of a screw supported on two brass pillars over the middle of the spring (which screw can be moved to the proper distance, to cause the vibrations to continue with the best effect), the current from the battery is carried through the helix, spring, and electro-magnet, by connecting wires fastened in the brass cups, with binding screws at the side of the machine. The fine wires are connected with cups at the end of the machine, and in which are secured wires connecting with handles, or other conductors, for communicating the effect.

The galvanic battery consists of an oblong square vessel, or box of copper, having a space all around, of about an inch, inclosed with copper, for the liquid; and within which is suspended a square frame of zinc, so arranged as not to be in contact with the copper, it being supported by cross bars of metal under which wood is fastened, to insulate it from the copper. There is a small tube in one of the corners of the zinc, and also of the copper vessel, to insert the connecting wires from the machine. There is a projecting piece within each end of the inner apartment of the battery to set the zinc on when not in use. The space in the middle contains the machine when transported, also the conductors, wires, &c. The liquid employed is blue vitriol (sulphate of copper), dissolved in hot water, about two ounces to a quart of water, left to cool before using. The liquid requires to be renewed when the acid is entirely taken up by the zinc, which will be known by there being no deposit on the zinc, after being immersed for a few minutes; in which case the liquid is poured out, and a new solution made, also any sediment cleaned out. The zinc frame should be left in the solution only while the application is made, as it soon becomes coated with a deposit which should be cleaned off after using, or if left to dry on may be scraped off with an old knife, a clean surface of zinc being necessary to the perfect operation of the machine. The solution may remain in the copper any length of time, as it does not act on it.

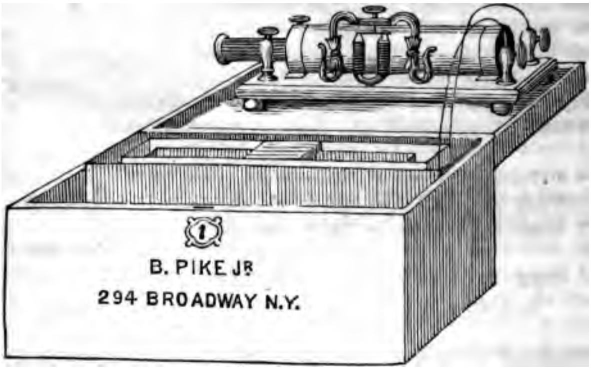
Directions.—Fill the exterior apartment of the copper box about half or two-thirds full of water, in which is dissolved an ounce and a half of blue vitriol. Place the zinc frame within it, care being taken to keep the zinc free from contact with the copper, in all directions. Fasten one end of one of the connecting wires securely in the hole in the corner of the zinc, the other wire in the copper, and the other ends in the cups with binding screws at the side of the instrument. Touch the spring with the finger, and the vibrations will continue by the power of the battery. The effect is received from handles, or conductors, attached to wires secured in the cups with screws at the end of the instrument. The flat conductors, with cork handles, are to apply to or around any diseased part; or one handle may be held in the hand, and one of the conductors applied around the part affected. These are pleasantly used with a sponge tied over one of *them, and* wet with water. Metallic plates are also used to place the foot on, or to apply to any part under the clothes. It may be used agreeably, and with much effect, by the patient holding one of the handles, and another person the other handle, and with the other hand making passes over or around the diseased part. This is particularly useful about the head, and where the pain is under the hair it should be thoroughly wet, to have the effect pass through it. The best effects have followed from regular applications of a mild power, from five to fifteen minutes, twice or more a day; a great power in many cases of nervous disease failing to secure the best effects, by the reaction produced in the system. The machine may be used with confidence, no injury being known to result from its use. Five sizes in polished mahogany cases, with a pair of conductors and foot plate.

Price,	extra large size contained in a case,	13 in. long,	8 in. wide,	6 in. deep,	$15.00.
"	1st size,	11 " "	6 " "	4½ " "	$12.00.
"	2d "	9 " "	5 " "	4 " "	$10.00.
"	3d "	7 " "	4 " "	3 " " very portable,	$10.00.
"	2d " with battery packed below the machine,	7½ in. long,	3½ in. wide,	6 in. deep,	$ 8.00

Improved Graduated Magnetic Machine, for Medical purposes (Fig. 472, next page), being the most perfect, convenient, and portable instrument in use, with all the improvements to 1848.

Description.—The machine consists of a double coil or helix of coarse copper wire, insulated, over which is wound about a thousand feet of fine insulated copper wire, in the interior of which is placed a rod formed of soft iron wires, and which, when the machine is in operation, becomes a powerful magnet, and regulates the strength of the power according to the extent the rod is placed in. At one side of the machine is an electro-magnet, formed of soft iron, and bent in the form of a U, and wound with two coils of covered copper wire, one end of which is soldered in the magnet, and the other communicated with the coarse helix. To one end or pole of the electro-magnet is fastened a spring, with a small hammer at one end, and just over the pole of the electro-magnet; and through which spring the power of the battery flows, *from the* point of a screw supported on two brass pillars, over the middle of the spring (which screw can be moved to the proper distance, to cause the vibrations to continue with the best effect); the current from the battery is carried through the helix, spring, and electro-magnet, by connecting wires fastened in the brass cups, with binding screws at the side of the machine. The fine wires are connected with cups at the end of the machine, and in which are secured wires connecting with handles, or other conductors, for communicating the effect.

Fig. 472.

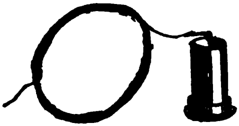


The galvanic battery consists of an oblong square vessel, or box of copper, having a space all around of about an inch inclosed with copper for the liquid, and within which is suspended a square frame of zinc, so arranged as not to be in contact with the copper, it being supported by a cross-bar of metal, under which wood is fastened to insulate it from the copper. There is a small tube in one of the corners of the zinc, and also of the copper vessel, to insert the connecting wires from the machine. There is a projecting piece within each end of the inner apartment of the battery to set the zinc on when not in use. The liquid employed is blue vitriol (sulphate of copper), dissolved in hot water, about two ounces to a quart of water, left to cool before using. The liquid requires to be renewed when the acid is entirely taken up by the zinc, which will be known by there being no deposit on the zinc, after being immersed for a few minutes; in which case the liquid is poured out, and a new solution made, also any sediment cleaned out. The zinc frame ıld be left in the solution only while the application is le, as it soon becomes coated with a deposit which should leaned off after using, or if left to dry on may be scraped with an old knife; a clean surface of zinc being neces- r to the perfect operation of the machine. The solution r remain in the copper any length of time, as it does not on it.

irections to Use the Machine.—Fill the exterior apart- ıt of the copper box about half or two-thirds full of wa- in which is dissolved an ounce and a half of blue vitriol. e the zinc frame within it, care being taken to keep the free from contact with the copper, in all directions. ten one end of one of the connecting wires securely in hole in the corner of the zinc, the other wire in the cop- and the other end in the cups with binding screws at side of the instrument. Touch the spring with the finger, the vibrations will continue by the power of the battery. effect is received from conductors, attached to wires, ıred in the cups with screws at the end of the instrument. conductors, with insulated handles, are to apply to or ınd any diseased part; or one may be held in the hand, the other conductor applied around the part affected. y are pleasantly used with a sponge tied over one of n, and wet with water. A metallic plate is also used to e the foot on, or to apply to any part under the clothes. nay be used agreeably, and with much effect, by the ent holding one of the conductors, and another person other conductor, and with the other hand making passes : or around the diseased part. This is particularly use- about the head, and where the pain is under the hair it ıld be thoroughly wet, to have the effect pass through The best effects have followed from regular applications mild power, from five to fifteen minutes, twice or more a ,—a great power in many cases of Nervous Disease fail- to secure the best effects, by the reaction produced in system. The machine may be used with confidence, no ry being known to result from its use.

Price, large size, in polished mahogany case,
4-inch high, 7-inch wide, 9-inch long, $10.00.
" polished rosewood case, - 50 cts. extra.
" small size, in polished mahogany case,
3½-inch high, 6-inch wide, 7½-in. long, $8.00.
" polished rosewood case, - 50 cts. extra.

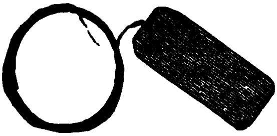
Fig. 473.



Conductors for the Magnetic Machine.—(Fig. 473.)—Insulated conductors with cork handles and long insulated wires for transmitting the magnetic current through particular parts of the human body, without the medical operator being in any degree affected; a pair of these accompany all of the magnetic machines for medical purposes.

Price, per pair, - - - - - - $0.50.
" with screws for connecting the wires, $1.00.

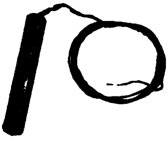
Fig. 474.



Metallic plate (Fig. 474) with long covered wire. This is used for conducting the current from the machine to one or both feet, the back, or any other part where a plate may advantageously be applied, and may be readily passed under the clothes to various parts of the body; this also accompanies all of the magnetic machines.

Price, - - - - - - $0.25.
" with screw for connecting the wire, $0.50.

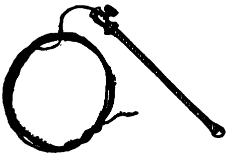
Fig. 475.



A pair of brass conductors (Fig. 475.) for the hands, being the most convenient form for applying the fluid to the system for general purposes. These accompany the best magnetic instruments.

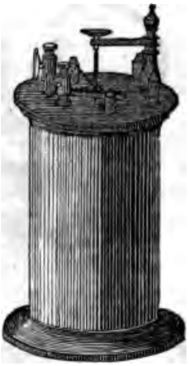
Price, per pair, - - $0.50.
" with screws to connect the wires, - - $1.00.

Fig. 476.



Silver conductor (Fig. 476) for the eye, ear, mouth, &c. This is a small silver ball of one quarter to half an inch in diameter, having a long insulated handle terminated with a screw cup for connecting the wire, and is used principally for the eye, ear, mouth, around ulcers and sores, and *also for various* other applications. Price, 50cts.

Fig. 477.

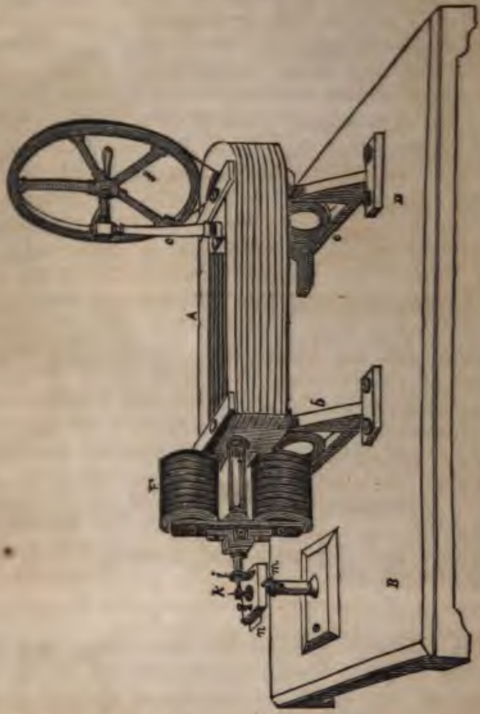


Inclosed Magnetic Instruments for Shocks.—(Fig. 477.)—This instrument consists of an electro-magnet, formed of a bundle of soft iron wires, wound with a double coil of coarse insulated copper wire, over which is wound a coil of fine wire, and inclosed in a cylinder of brass about four inches in diameter and six inches long, supported on a base, and having a cap of mahogany through which the poles of the electro-magnet project, and over which there is one of Page's revolving armatures, supported by a brass pillar and arm, having on one side a small spring pressing the break-piece. The inner coil is connected with the cups on each side of the pillar, and the spring acting on the break-piece, while the fine coil is connected with the cups with binding screws on the opposite side of the cup; the handles for receiving the shocks are connected with these cups, while the battery current flows through the cups on each side the brass pillar. The shock given with this instrument is quite severe, and does not admit of being reduced as in the preceding instruments. Price, $6.00.

Saxton's Magneto-Electric Machine.—(Fig. 478, next page.)—The magneto-electric machine is one of the most interesting and instructive instruments of modern science; by it we see exemplified the close connexion between, if not the identity of, the electric and magnetic forces; by it the same heating, magnetizing, and decomposing power, the same chemical effects, are shown to be common to both.

A, is a compound horse-shoe magnet, composed of six or more bars, and supported on the rests, *b*, *e*, which are screwed firmly on the board, B D; into the rest, *e*, is screwed the brass pillar, *c*, carrying the large wheel, *f*, having a groove in its circumference, and a handle by which it can readily be revolved on its axis; a spindle passes from one end of the magnet to the other between the poles, and projects beyond them about three inches, where it terminates in a screw at *h*, to which the armature is attached; at the further extremity is a small pulley, over which a gut band

Fig. 478.



passes, by means of which, and the multiplying wheel, *f*, the armature can be revolved with great velocity.

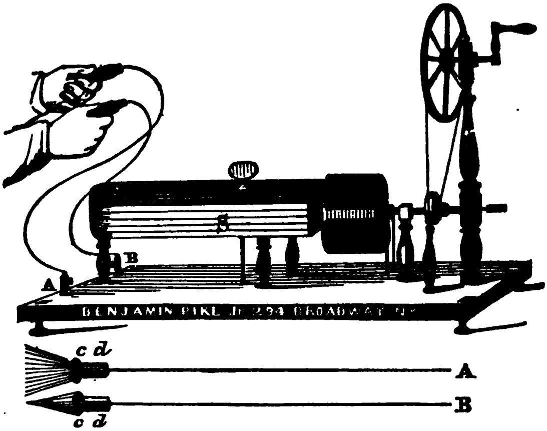
The armatures or inductors, as seen at F, are nothing more than electro-magnets; two pieces of round iron are attached to a cross piece, into the centre of which the spindle, *h*, screws; round each of these bars is wound in a continuous circuit a quantity of insulated copper wire, one end being soldered to the round disc, *i*, the other connected with the copper wire passing through, but insulated from it by an ivory ring. By means of the wheel and spindle, each pole of the armature is brought in rapid succession opposite each pole of the magnet, and that as near as possible without absolutely touching. The two armatures differ from one another. The one termed the quantity armature is constructed of stout iron, and covered with thick insulated wire. The other, the intensity armature, is constructed of slighter iron, and covered with from 1000 to 2000 yards, according to the size of the instrument, of fine insulated wire.

The quantity armature is adapted for exhibiting the magnetic spark, inducing magnetism in soft iron, heating platinum wire, &c. The intensity is best adapted for administering the magnetic shock. A few words will suffice to explain the theory of the magneto-electrical machine, as at present understood; as often as the bent ends of the armatures or inductors, F, F, F, are brought by the rotation of the wheel opposite the poles of the magnet, they become, by induction, magnetic; but they cease to be so when they are in the position shown in the cut, viz. at right angles to it. Now, at the moment of the induction as well as of the destruction of the magnetism in an iron bar surrounded by copper wire, opposite currents of electricity are induced in the wire if the circuit be complete; the points, *k*, are therefore so arranged that they shall leave the mercury and thus break the circuit in the wire surrounding the armature, F, at the moment that its ends become opposed to the poles of the magnet; for which purpose they must be placed nearly at right angles to it: the circuit is thus broken at the precise moment that a rush or wave of electricity is determined in the wire, and hence the electrical effects that are obtained.

Price, $50.00.

Magneto-Electric Machine.—(Fig. 479, next page.)—This instrument consists of a compound horse-shoe magnet, composed of five bars, and supported on a mahogany base by three brass pillars, being held firmly thereon by a strong screw; to the base a strong brass pillar is fastened, carrying a brass wheel eight inches in diameter, having a groove in its circumference, and a handle for turning it on its axis. A spindle is supported by a shorter pillar, by passing through and working against a collar, and supported at the end by a screw in the longer pillar, the point of which enters the centre of the spindle. To the end of the spindle, projecting through the shorter pillar, is fixed an armature, consisting of a bar of soft iron, bent at right angles, and surmounted with coils of fine insulated copper wire, each coil wound in

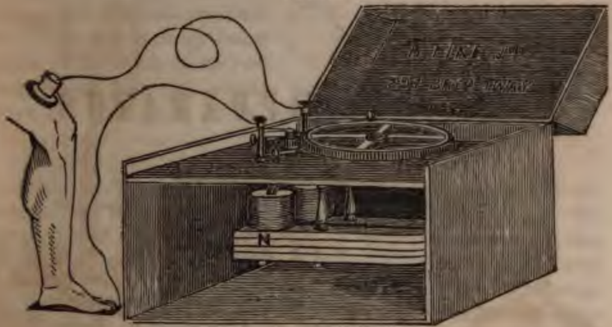
Fig. 479.


BENJAMIN PIKE Jr 294 BROADWAY N.Y
B
A
S
c d
A
B
c d

a continuous circuit, and joined together, the ends of the coil being soldered to the opposite sides of a break-piece on the spindle, which is formed of two segments of a silver cylinder, fastened to a ferule of ivory on the spindle, and separated from contact with each other by a small space. To the spindle is fastened a pulley, connected by a catgut band with the wheel above, by the turning of which each pole of the armature may be brought, in rapid succession, opposite each pole of the magnet, and as near as possible without touching. Two silver springs press against the opposite sides of the break-piece, and are connected below the base by wires soldered to the cups with binding screws on the base. With this arrangement, water may readily be decomposed, and for strong shocks, a break is attached to the spindle, against which a spring presses, supported by a pillar, and at the base connected with one of the silver springs of the break-piece. Price, $25.00 and $35.00.

Improved Magneto-Electric Machine in Box—Motion by Toothed Wheel.—(Fig. 480, next page.)—In this arrangement the magnets are supported beneath a mahogany board, in a horizontal position, by three brass pillars, the armatures revolving over the poles, and motion being given to them by

Fig. 480.

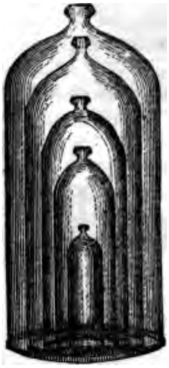


a cog-wheel on the spindle, acting in the teeth of a larger wheel, which is turned by the hand, thus preventing the trouble of constantly adjusting the bands, as in the usual construction; the whole is enclosed in a mahogany case, and may either be used in the box, or taken out.

Price, - - - $32.00.
" without toothed wheel, $27.00.

CHEMICAL APPARATUS.

Fig. 481.



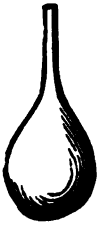
Bell Glass Receiver.—This is used in experiments on the air, or gases, and is a glass vessel of the shape represented in Fig. 481, and of various sizes, from a gill to several gallons. There is a knob on the top, which is used as a handle for moving it by.

Price, one gallon, with ground bottom,	-	-	$1.00.
" half gallon,	"	"	$0.75.
" quart,	"	"	$0.50.
" pint,	"	"	$0.40.
" half pint,	"	"	$0.30.
" gill,	"	"	$0.25.

Stoppered Bell Glasses.—Bell glasses with ground stoppers for introducing phosphorus, steel wire, the metals, or any other substance for burning in the gases, &c.

Price, one gallon,	-	-	$1.25.
" half gallon,	-	-	$1.00.
" quart,	-	-	$0.75.
" pint,	-	-	$0.50.
" half pint,	-	-	$0.40.
" gill, -	-	-	$0.30.

Fig. 482.



Flasks.—(Fig. 482.)—These are made of glass, They are used in distilling and boiling various solutions, and will stand a greater heat without breaking than any other description of glass.

Price, from 8 cts. to 37 cts.

Fig. 483.

Matrass or Bolt Head.—(Fig. 483.)—The matrass or bolt head is a globular glass vessel with a narrow long neck, used by chemists in digestions and other operations. Price, gill, $0.25; half pint, $0.31.
" pint, $0.38; quart, $0.50.

Retort.—A chemical instrument, for holding solids or liquids for the purpose of distillation. According to the heat that it is to be submitted to, and the nature of the substance contained, so retorts are of different forms, and made of different materials; thus for the making of various gases cast-iron retorts are commonly employed. Fluorine requires one of silver or lead. In the manufacture of the acids, earthenware retorts are mostly employed; and for ordinary purposes of distillation, and other chemical operations, glass is the material approved of.

Glass Retort.—(Figs. 484, 485, 486, next page .)—Retorts are vessels employed in a variety of distillations, and most frequently for those which require a degree of heat superior to that of boiling water. This vessel is a kind of bottle with a long neck, so bent that it makes with the belly of the retort an angle of about sixty degrees. The most capacious part of the retort is called its belly; its upper part is called the arch or roof of the retort; and the bent part is the neck. They are made of glass, porcelain, and stoneware, of a great variety of sizes, plain and with stoppers. The tubulated or stoppered retort has an opening, or tubular, for introducing the materials to be acted upon, and this opening also allows of an addition being made to such materials while the retort is at work.

Price, flint	glass	retorts,		gill,	$0.25.
"	"	"		half pint,	$0.31.
"	"	"		pint,	$0.37.
"	"	"		quart,	$0.50.
"	"	"	stoppered,	gill,	$0.31.
"	"	"	"	half pint,	$0.37.
"	"	"	"	pint,	$0.44.
"	"	"	"	quart,	$0.63.
"	"	"	"	half gall.,	$0.88.
"	"	"	"	gallon,	$137.

Price,	best porcelain retorts,				$0.75 to $2.50.
“	stone-ware,	glazed—	plain,	4 ounce,	$0.40.
“	“	“	“	8 “	$0.50.
“	“	“	“	pint,	$0.62.
“	“	“	“	quart,	$0.75.
“	“	“	“	half gall.,	$1.00.
“	“	“	tubulated,	4 ounce,	$0.50.
“	“	“	“	8 “	$0.62.
“	“	“	“	pint,	$0.75.
“	“	“	“	quart,	$0.88.
“	“	“	“	half gall.,	$1.25.

Fig. 484.

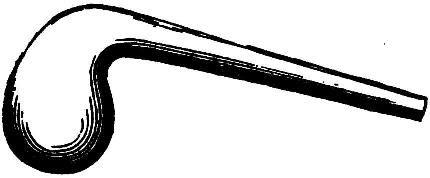


Fig. 485.

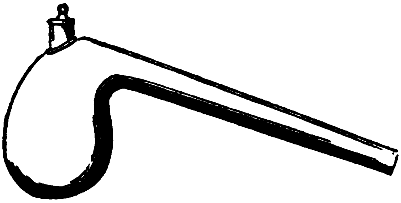


Fig. 486.

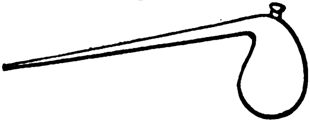
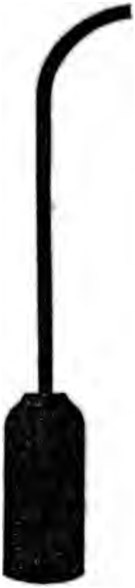


Fig. 487.



Iron Retort for Oxygen.—(Fig. 487, as above.)—This is an iron vessel shaped usually in the form of a bottle, holding from one pint and upwards, and having an iron tube, bent or straight, screwed, or ground conically into the neck, and is used principally in producing oxygen gas.

Price, $2.00 and $2.50.

Fig. 488.

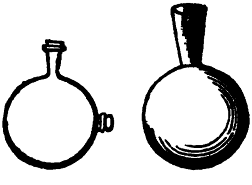
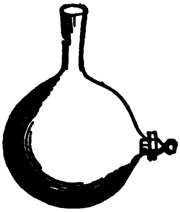


Fig. 489.



Globe Receivers.—(Figs. 488 and 489, as above.)—Receivers are vessels, usually of glass, of a spherical form, with a straight neck, into which the neck of the retort is usually inserted. When any proper substance is put into a retort, and heated, its volatile parts pass over into the receiver, where they are condensed. They are made plain and tubulated, with ground stoppers.

Price,	- -	gill,	25cts.;	½ pint,	25cts.
"	- -	pint,	37cts.;	quart,	50cts.
"	stoppered,	gill,	31cts.;	½ pint,	37cts.
"	"	pint,	44cts.;	quart,	63cts.

Fig. 490.

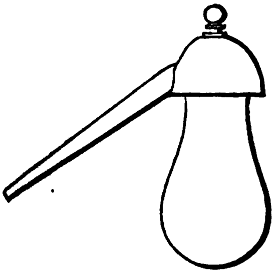
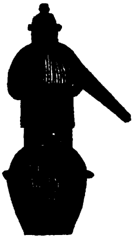


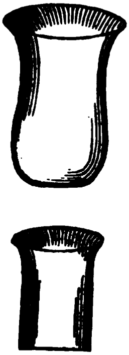
Fig. 491.



The Alembic, for Sublimation and Distillation.—(Figs. 490 and 491, as above.)—The alembic is used for distillation, when the products are too volatile to admit of the use of the retort. The alembic consists of a body, to which is adapted a head. The head is of a conical figure, and has its external circumference or base depressed lower than its neck, so that the vapors which rise, and are condensed against its sides, run down into the circular channel formed

by its depressed part, from whence they are conveyed by the nose or beak into the receiver. They are made of glass and stone ware glazed, usually of the capacity of one quart.
Price, $2.50.

Fig. 492.



Figs. 493.

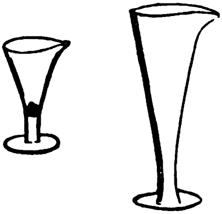
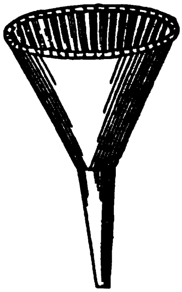


Fig. 494.



Beaker Glasses.—(Fig. 492, as above.)—These glasses are used for a variety of purposes in chemistry, viz. for mixing solutions and precipitating, also for boiling and even extracting any solution. They are generally made of very thin glass, and of the shape shown in the cut. They are particularly useful for boiling and concentrating solutions, and if made of good glass, will stand heat well. Care must be observed in selecting them, to see that the glass of which they are made contains no flaws, and also that it is equal in thickness, otherwise they are apt to crack. Four of them are sufficient for general use, commencing with one to hold two ounces, and increasing in size to half a pint.
Price, 20cts. to 50cts.

Precipitating Glasses.—(Fig. 493, as above.)—These are made of glass, and in various shapes; those, however, shown in the figures are the best forms. They are used in precipitating salts or other substances from the solutions in which they are formed. Price, 15cts. to 25cts.

Funnels.—(Fig. 494, as above.)—These are best made of glass, and should be ribbed on the sides. They are used for pouring liquids from one bottle to another, and also to support filter-papers when filtering any liquids.

Price, gill, 15cts. : ½ pint, 18cts.
" pint, 25cts. ; quart, 38cts.

Fig. 495.

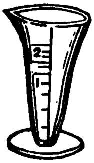


Fig. 497.

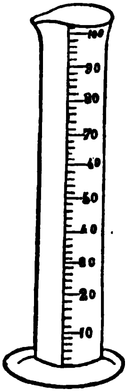
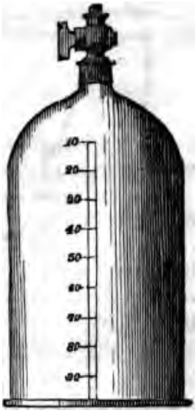


Fig. 498.



Graduated Measure Glasses.—(Fig. 495, as above.)—These are made of strong glass, and are used for measuring liquids. They are of various sizes, but one of six ounces is the most useful. The quantity is marked by a graduated scale at the side, and usually commences with half a drachm, and so proceeds drachm by drachm to half an ounce, and upwards to an ounce or more.

Price, 2 ounce, $0.62 ; 3 ounce, $0.75.
" 4 " $1.00 ; 8 " $1.25.

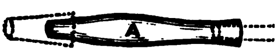
Graduated Glass Jar on foot.—(Fig. 496, as above.)—This consists of a cylindrical glass jar with lip, on a foot, and graduated into 100 equal parts, or into cubic inches ; they are usually ten inches high and two inches wide.

Price, $2.00 ; smaller, $1.50.

Graduated Bell Glass.—(Fig. 497, as above.)—This consists of a tubulated bell glass, with cap and stop-cock, graduated into 100 equal parts, and used in measuring volumes of gas, transferring given quantities, &c.

Price, with stop-cock, pint, $2.75; quart, $3.00;
" " " ½ gall. $3.50; gallon, $4.00.

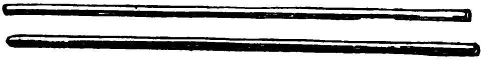
Fig. 498.



Adapter.—(Fig. 498).—A glass tube open at both ends, used to connect a retort with its receiver whenthe neck of the former is not long enough. Price, 25 cts. to 50 cts.

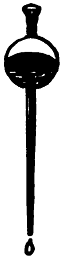
Tubes of Glass, Porcelain, &c.—(Fig. 499, as below.)—Tubes are made of glass, porcelain, stone-ware, brass, and lead, and are used in distillation, evaporation, to connect apparatus for the conveyance of liquids and gases, and for other purposes, and may be obtained straight or bent in any form required; they are usually furnished in lengths of about three feet long, varying in diameter from one eighth of an inch to one and a half. Porcelain and stone-ware tubes are usually about one inch in diameter, and two feet long; small sized lead and brass tubes may be obtained in lengths of ten feet or more. Flexible tubes, the foundation being a spiral formed of twined iron wire, over which fine twine is braided, and then a coating of india rubber, and over that a braid of fancy colored twine, which is varnished and highly polished; forming an elegant, useful, and very durable tube that may be bent in any manner, being quite flexible, and of important use in many pneumatic experiments, also used for conveying the gases in hydro-oxygen microscopes, compound blow pipes, dissolving view apparatus, &c.

Fig. 499.



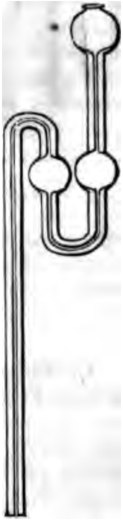
Price, small glass tubes in lengths of 3 ft., 15 cts. to 25 cts.
" larger " " 31 cts. to 50 cts. or 63 cts. each.
" fine porcelain tubes, 18 inches long, 63 cts. "
" " stone-ware, " " 38 cts. to 63 cts. "
" small lead, per foot, - - - - 8 cts.
" " brass, " - - 12½ cts. to 18 cts.
" flexible tubes, half inch diameter, per foot, 86 cts.

Fig. 500.



Dropping Tube, or Pipette.—(Fig. 500.)—The dropping tube, or separating funnel, is a tube of glass, drawn to a point at one end, and furnished with a bulb in some part of its length, both ends being open. To use it, immerse the finer end in the liquid to be taken up, and thrust it down; the liquid will rise until it finds its level withinside; then closing the upper end with the finger, it may be conveyed away. The partial or total removal of the finger occasions the fluid to drop from the lower end. Closing it again with the finger stops the flowing; and thus, if there are two liquids in the tube, such as oil and water, the one may be separated from the other. Price, $0.38.

Fig. 501.



Tube of Safety.—(Fig. 501.)—A tube open at both ends, inserted into a receiver, the upper end communicating with the external air; the lower being immersed in water. Its intention is to prevent injury from too sudden condensation or rarefaction taking place during an operation. For if a vacuum be produced within the vessel, the external air will enter through the tube, and if the air be generated, the water will yield to the pressure from the confined gas or gases. It is now more frequently used of a curved form, like that represented in the cut, with or without a bulb in the upright stem; the lower end of this, instead of being immersed under the liquid in the receiver as the straight tube, is merely inserted into the tube. The requisite tightness and pressure is obtained by pouring a little mer cury, or in some cases oil, into the tube; this resting in the legs of the lower bend, keeps the vessel perfectly air-tight.

Price, 75cts.

Test Tubes and Stand.—(Figs. 502 and 503, page 68.)—Test tubes are made of glass, and for convenience are used with a stand, but sometimes test glasses are used when the stand is not required. These tubes are for testing small quantities of the liquid or mixture under analysis. For instance, if you suspect some substance to be present in the solution and wish to ascertain whether it is so or not, you pour a small quantity of the solution into a test tube or glass, and then add any other solution known to act on the substance you suspect to be present. The solution you add is known in chemistry as a re-agent. You must then judge by the result you observe in the solution, on the re-agent being added, whether the substance you suspect is present or not.

Price,	3 in.	38cts.	doz.
"	4 in.	50cts.	"
"	5 in.	63cts.	"
"	6 in.	75cts.	"
"	6 in mahogany frame,	$1.00.	

Fig. 502.

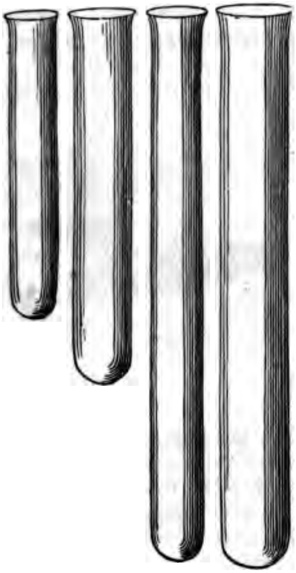
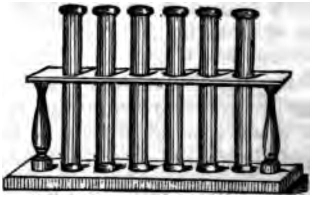


Fig. 503.



Air Thermometer.—(Figs. 504 and 505, next page.)—This instrument consists of a glass vessel or bottle, with a broad base and narrow neck, containing a colored liquid, *a*; a long tube having a glass bulb blown at one end, *b*, the other extremity of the tube being open, and plunged in the colored liquid; and a scale of equal parts, *c*. Heat is applied to the bulb to expel a part of the air, which permits a portion of the colored fluid to rise in the tube; this fluid column indicates the slightest changes of temperature by rising when it is diminished, and falling when it is increased; because every increase of temperature expands the air in the bulb, occasioning it to press upon the fluid column and force it down, while any decrease of temperature contracts the bulk of the air, and permits the fluid to rise. This instrument is not capable of measuring variations of temperature through any very considerable range, and it is liable to other objections; yet, notwithstanding, it is still applicable, from its great delicacy, to many purposes.

Price, with dividing scale (Fig. 505) $1.00.
" without, " " " $0.50.
" tube only (Fig. 504) - $0.19.

Fig. 504.

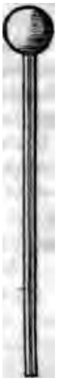


Fig. 505.

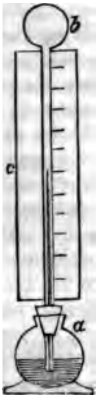


Fig. 506.

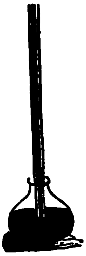
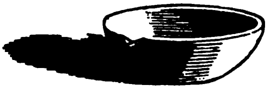


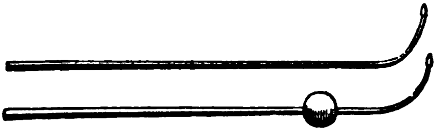
Fig. 507.



Boyle's Thermometer.—(Fig. 506, as above.)—One of the earlier, and consequently more imperfect thermometers. It is, however, superior to any previously in use. It is simply a glass tube, open at both ends; one end cemented into a bottle half full of some liquid; the cement preventing any escape of the air which is above the liquid. Any increase of temperature rarifies the air, and drives the liquid further up the tube; on the contrary, a decrease of temperature occasions it to subside. There was no scale attached to this thermometer.

Evaporating Dishes.—(Fig. 507, as above.)—These are best made of Wedgewood's ware, and are employed in the evaporation of solutions, so as to enable the dissolved body to assume the crystalline form. These dishes are made in such a manner, that a large surface of the liquid to be evaporated, may be exposed to the air at one time. They usually have a lip for the convenient pouring off of any remaining liquid, after the crystals are formed on the bottom of the dish. They are made of a variety of sizes, usually from *two to seven inches in diameter.* Price, 25cts. to 63cts.

Fig. 508.



Blow-Pipe.—(Fig. 508, as above.)—This is an instrument by which a small jet of air is directed laterally into the flame of a lamp or candle, so as to divert it in a long slender cone upon a piece of charcoal or other substance so placed as to receive it. When a flame is thus urged by the blow-pipe, the extreme heat is just at the tip of the outer white flame, where the combustion is most perfect, and where substances are rapidly burned or oxidized; whilst the interior blue flame, in consequence of its excess of combustible matter, abstracts oxygen from, or reduces substances. So that several metals, when thus heated before the blow-pipe, are alternately oxidized or de-oxidized by being placed in the outer and inner flame. The blow-pipe is of important service to the chemist, in enabling him to ascertain easily and quickly, the effects of intense heat upon a variety of substances; and he frequently has recourse to it in order to distinguish metallic and earthy minerals from each other, and to ascertain in a general way, the nature of their component parts. Price, 38cts. and 50cts.

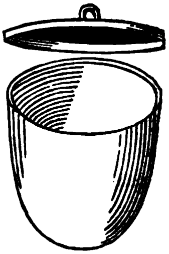
Blow pipes, with reservoirs for condensing the moisture of the breath. Price, 63cts. and $1.50.

Fig. 509.

Crucibles.—(Fig. 509.)—The crucible is a vessel usually made of well hardened earthen or stone ware, in constant use in the chemical laboratory for performing fusions of metals and other substances.

Price, 6 cts. to 38 cts. per nest.

Fig. 510.

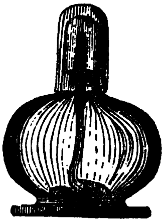


(Fig. 510.)—Small crucibles of Wedgewood's ware, with or without covers.
Price, 25 cts. to 50 cts.

Spirit Lamp.—(Fig. 511.)—A small lamp which is fed by spirits of wine, rather than by oil, producing a large and hot flame, though little light and no smoke; the lamp being used in chemical operations, to heat retorts, test tubes, &c., and not for the light it affords. Spirit lamps are usually made of glass, with a brass top to hold the wick, and supplied with a cover, which fits over the top when it is desirous to extinguish the flame.

Price, - - - $0.75.
" extra large, $1.00 and $1.25.

Fig. 511.

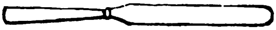


Mortar and Pestles—(Fig. 512.)—are so well known in every day use, that a description is scarcely necessary. The chemist requires for general use, one of glass, Wedgewood's ware, or marble, with pestle of the same description. They are used to pulverize and mix minerals, earths, and other substances; as it is necessary in analysing to reduce nearly all the substances to powder before you commence the analysis.
Price, 50 cts. to $1.50.

Fig. 512.

Spatulas.—(Fig. 513.)—These are made of steel, and are used to mix powders, to scrape out the contents of mortars and capsules, &c. Price, 38 cts.

Fig. 513.



Retort Stands (Figs. 514 and 515, next page), with flat, oval, or rectangular foot, rod twenty inches long, having three rings two and a half, three and a quarter, and four inches in diameter, with brass sockets and thumb screw.
Price, $1.50.

Fig. 514.

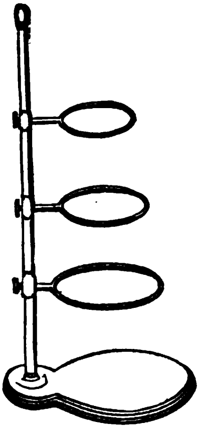
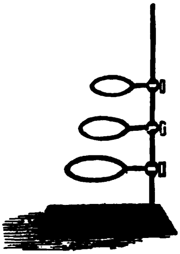


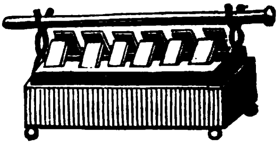
Fig. 515.



Retort stands with rectangular iron base, ten inches long, having two rods and six rings of the size of the former.

Price, $3,00.

Fig. 516.



Cooper's Lamp Furnace.—(Fig. 516, as above.)—A lamp which is made of an elongated form, and is furnished with two rows of broad wicks, the whole or part of which may be lighted at once. Professor Faraday recommends this simple furnace as valuable for the heating of tubes, or any long and narrow vessel. Near the ends are two twisted wires, for the support of the tube to be heated.

Price, $2.00.

Knight's Assay Lamp.—(Fig. 517, next page.)—Such is the name given by Mr. Knight, Foster Lane, to an extremely useful Argand lamp, adapted to heat retorts, and for general chemical purposes. A is a flat, short, cylindrical vessel, for containing the oil. B is a double cylinder of tin, about an inch in diameter. The outer cylinder passes through, and is soldered air-tight to the oil vessel; the inner cylinder passes from the holes below to the centre of the flame. The oil and the cotton pass between the two cylinders. B is furnished with a screw below, which screws on to the foot C. D is a rack and pinion to regulate the height of the wick. E, E, E, are three wires, formed into a frame-work to support anything which is to be heated; these wires slide up and down in sockets on the sides of A and C. F is a hole for *the supply of oil.* There is usually a copper tube placed over the flame, in the manner of a lamp-glass, to concentrate the heat by preventing its radiation sideways.

Price, $5.00.

Fig. 517.

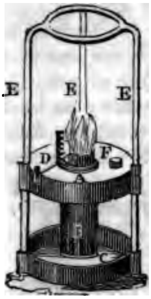


Fig 518.

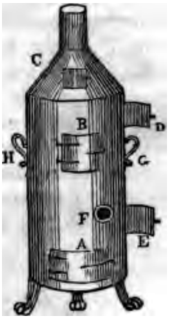
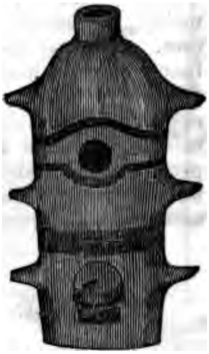


Fig. 519.



Knight's Chemical Furnace.—(Fig. 518, as above.)—This is one of simple construction and of general application. It is represented as follows:—A, is the ash-hole door; B, the fire-place door, in which muffles, crucibles, &c., are to be introduced; C, a door above the fire for introducing retorts. The top also may be wholly removed to insert a still or sand bath. D, E, are doors of different heights, leading to the fire, for the more convenient introduction of different apparatus; F, the hole for the introduction of a gun barrel: G and H, handles by which the whole furnace may be removed.

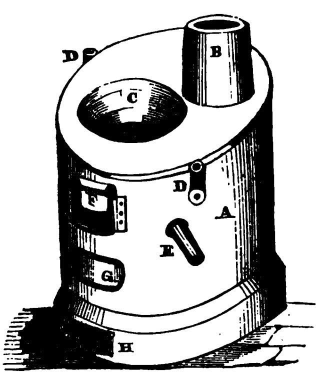
Price, $8.00 to $12.00.

Stone Ware Portable Table Furnace.—(Fig. 519, as above.)—This furnace of stone ware, and capable of standing an intense heat, consists of three parts that fit upon each other, each part being firmly bound with iron hoops. A fire made in the bottom part—the two upper pieces being removed—will serve for heating materials in crucibles, ladles, retorts, &c. If the middle portion of the furnace is placed above the bottom part, a larger fire may be made, and if an iron or copper dish be fitted into the upper rim, it may be used for heating sand; and thus a small sand bath will be obtained, in which retorts, flasks, evaporating dishes, &c.,

may be placed, for the purpose of carrying on a variety of operations. When the roof, or uppermost part, is placed above the middle portion, and the openings in the sides of the furnace closed, a very intense heat may be obtained, which will be applicable to several purposes, such as the melting of metals, and the reduction of metals from their ores. The heat may be further increased, by affixing a long funnel of sheet iron to the chimney, so as to increase the draught of air through the fire. Two holes are made on opposite sides of the furnace, to enable an iron or porcelain tube to be passed through the body of the fire; as in the production of hydrogen, these holes have stoppers fitting for effectually closing them when desired. Three sizes, seven, ten, and twelve inches in diameter.

Price, $3.75; $5.50; and $7.00.

Fig. 520



Dr. Black's Furnace.—(Fig. 520.)—A very serviceable portable furnace; used for chemical operations, and which may be applied to numerous other purposes.

A is a vessel of sheet iron, lined around the part where the fire is with fire brick, that the heat may be the better retained. B is the chimney, which may be lengthened at pleasure. C is an aperture at the top, for the reception of an iron sand or water bath. D, D, are two sockets for iron rods, which have a cross bar at top, to suspend various boilers by, that they may be over the fire. E is a porcelain tube or gun barrel, passing through the fire, for the production of certain gases. This may be removed when not wanted; when one hole being stopped up, the other will hold the nozzle of a pair of bellows. F is an aperture, with a sliding door for the reception of a muffle; G is a door, by which a crucible may be put in the fire; and H is the ash-pit. The fuel may be *kept in the cavity* under the chimney. Price, $15.00.

Tongs.—(Fig. 521, as below.)—Chemical tongs are made of iron. One pair straight, and another crooked should be obtained, and of the shape shown in the plate. Their use is so well known that further description is unnecessary.

Price, $1.00.

Fig. 521.

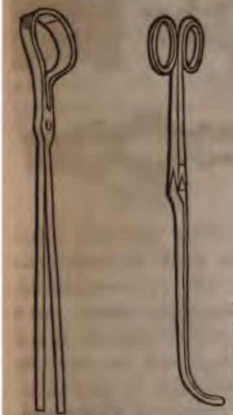
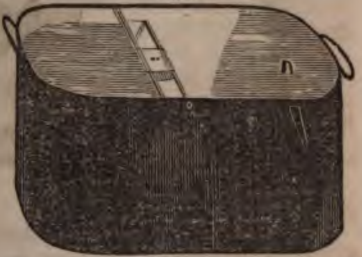


Fig. 522.



The Pneumatic Trough.—(Fig. 522.)—This consists of an oblong japanned tin vessel, which is filled within one or two inches of the top with water; just below the surface of the water is fixed a shelf, and also a sliding shelf supported by two wires, having a funnel on the under side; the sliding shelf may be set at any distance across the vessel; there is also a small spout at the side to prevent the water overflowing. The use of the pneumatic trough is in collecting gases. Supposing gas is issuing out of the beak of a retort, and that beak were placed beneath the funnel, the shelf being covered with water, it is evident that the gas would pass through the funnelled hole, and ascend into the air if the hole were uncovered, or else into a gas jar or other vessel placed over the hole. Also in passing through the water, the gas becomes purified and cooled.

Price, - $2.00.
" larger, $2.50.

Cooper's Mercurial Tube.—(Fig. 523, next page.)—This small instrument supplies the place of a mercurial trough. It consists of a bent tube, closed at top, open at the foot, supported in any manner which may be convenient, and filled previous to use with mercury. The open end is then connected with a retort, or alembic, which is giving off the gas to be collected. The gas rises up through the mercury and occupies the upper arm of the tube, while the mercury which is displaced drops into a dish put underneath to catch it. Price, 37 to 75cts.

Fig. 523.

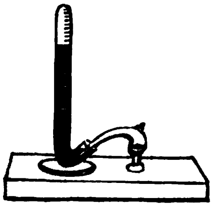
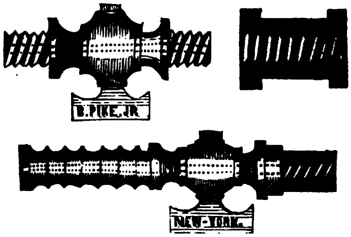
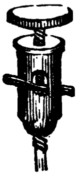


Fig. 524.



Stop-Cock.—(Fig. 524, as above.)—The ordinary name given to the small brass taps or cocks used in pneumatic apparatus, and of which the figures are representations. The first figure shows the common stop-cock, which has a male screw at each end. The figure on the side of it is a connecting piece, used to join one stop-cock to another, when it is necessary to transfer gases through or into them. The lower figure shows a stop-cock so contrived at one end, that a bladder may be firmly united to it; the other end having a small screw, to which a tube or other apparatus may be attached. Price, - - - - $0.75.
" large, for air pump apparatus, $1.00.
" connectors, - $0.25 to $0.50.



Binding Screw.—A term applied by opticians to denote the screws by which the wires of galvanic batteries, electro-magnetic apparatus, and other similar things are bound together, during the time of their action. As good metallic contact is necessary in electro-magnetic experiments, the extreme point of the upper screw, as well as the end of the wire to be inserted, should be made bright, when wanted for use in delicate experiments. Price, 25cts.

Bell-Glass and Bladder Apparatus.—(Fig. 525, next page.) —One of the most extensively useful and convenient articles of chemical apparatus is what is termed the bell-glass and bladder apparatus. It consists of a bell-glass, furnished with a brass cap and stop-cock, and a small connecting piece with two female screws, by means of which a second stop-cock, affixed to a bladder, or to any other vessel, may be connected with the stop-cock and the receiver. If the bladder has been previously compressed, and a communication be then made with the bell-glass by opening both stop-cocks, the gas contained in the bell-glass may of course be transferred into the bladder; by pressing down the bell-glass into the water of the pneumatic trough, the gas will be forced up into the bladder; the stop-cocks being then shut, the bladder must be removed.

Fig. 525.

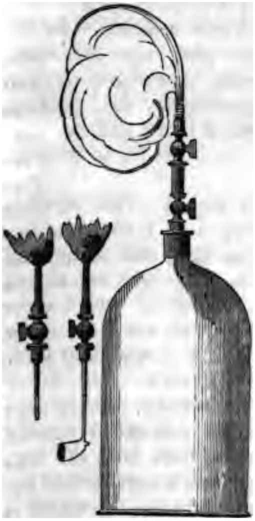
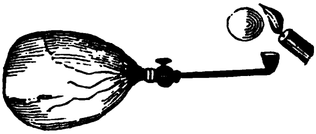


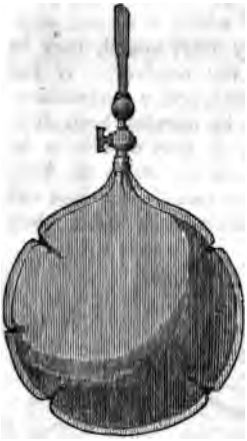
Fig. 526.



The above cut (Fig. 526) represents a brass tobacco-pipe, furnished with a stop-cock, that it may be connected with a bladder for throwing up soap-bubbles, filled with hydrogen gas, or with a mixture of hydrogen and oxygen gas, for explosion. Blow some soap bubbles, filling them from the bladder of hydrogen, furnished with a brass pipe; they will ascend rapidly to the ceiling; if they are intercepted in their course by a lighted candle, they will explode with a dull report, and a flash of yellow light. A jet is also connected with the apparatus, by which a small stream of hydrogen gas may be burned, and by holding a glass tube about two feet long over the flame, musical sounds will be produced by the vibration of the tube, which may be varied as the tube is raised or depressed.

Price, with jet, pipe, and gas bag, quart, $3.75.
" " " " " half gall., $4.00.
" " " " " gallon, $4.25.

Fig. 527.



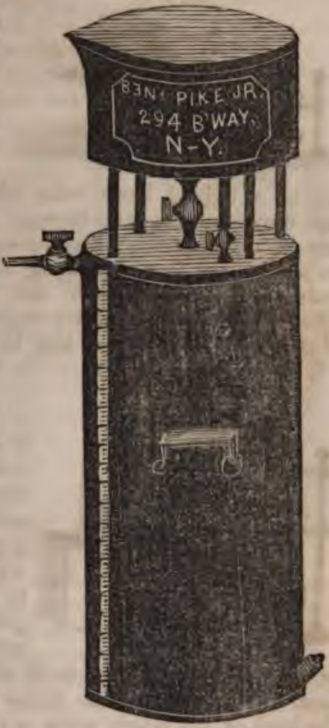
Flexible Gas Bags.—(Fig. 527.)—Gas bags made of India rubber cloth are very convenient for holding gases; they are made of various sizes, from one foot to two feet in diameter. One is represented in the cut, having a large stop-cock and mouth-piece, as used for inhaling nitrous oxide gas.

Price, 12-inch, - - -	$1.50.
" 15-inch, - - -	$2.00.
" 18-inch, - - -	$2.50.
" 24-inch, - -	$3.50.
" with large stop-cock and mouth-piece, -	$4.00.
" large gas bags for compound blow-pipes, oxygen microscopes, &c., holding from 5 to 40 gallons,	$4.00 to $20.00.

The Gas Holder.—(Fig. 528, next page.)—This consists of a body, or reservoir, closed at top and bottom, which may hold about eight gallons. Above this, and supported by four legs, is a cistern, open at the top, and connected with the body by two cocks; the larger of which (the centre one) has a pipe running down to very near the bottom, so that when the gas holder is but partly filled with gas, none can possibly escape by this cock. The other cock, which is between the cistern and body, merely connects the two vessels, and if left open the gas would rapidly escape through it. Another cock is attached near the top, on the side of the body, to draw off the gas when wanted for use, and near the bottom is a short thick tube, to which is fitted a cork or screw. To use the gas holder: tighten the screw on the end of the short tube at bottom, then open all three cocks at top, and fill the whole with water, by pouring a requisite quantity into the cistern. Now close all three of the upper cocks, and open the screw at the bottom. The water within will not flow out, although this hole is open. Into this hole the beak of the retort is to be fixed, as the gas rises from it the water will pour out below. The *quantity which* may be contained in the gas holder from time to time, is indicated by a graduated glass tube, which runs on the outside from the top to the bottom of it. When the gas holder is full, screw on again the end of the tube at bottom. When the gas is wanted for use, it may either be drawn off by the cock on the side, or on the top, being careful to open before either of them the cock in the middle, and keep the cistern filled with water, as this is wanted to occupy the receiver when the gas is drawn out.

Price, $6.50 to $10.

Fig. 528.


BEN. PIKE JR.
294 B'WAY.
N-Y.

Preparation of Gases.—(Fig. 529.)—To procure hydrogen from iron, sulphuric acid, and water. Put into a wine bottle a few iron nails, add some water, and then sulphuric acid, equal in quantity to one-fourth of the water; the iron nails will in a minute or two be covered with bubbles of gas, which will rise to the top of the vessel. Hold a candle near the gas as it passes away from the mouth of the bottle, and by its taking fire it will be known to be hydrogen. It may be collected either with a bent tube passing under the shelf of the pneumatic trough, or by a bladder fastened to the mouth of the bottle.

Fig. 529.

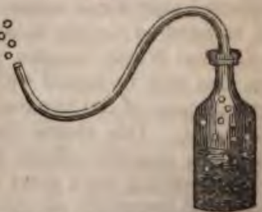
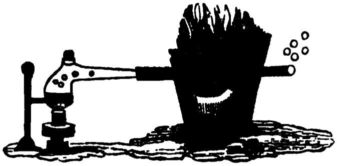
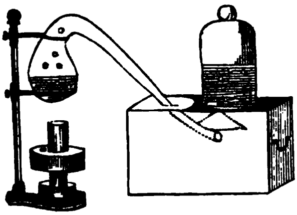


Fig. 530.



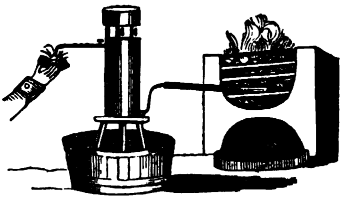
To procure Hydrogen from water.—(Fig. 530.)—Pass an iron tube, or gun barrel, open at both ends, through a fire. Make it red hot, and to one end fasten a retort holding water; make this water hot by a lighted lamp being placed under the retort, so that the steam may pass through the red hot iron tube. In this transit it will be decomposed, the oxygen being absorbed by the iron, rendering that an oxyde; while the hydrogen passes through, and may be collected at the other end of the tube, which ought to dip under the surface of the water, that the gas may be cooled and purified

Fig. 531.



To procure Nitrous Oxide, or Laughing Gas.—(Fig. 531.)—Place in a retort some crystals of the nitrate of ammonia; distil these with a gentle heat at first, afterwards increasing it gradually to about 400 degrees; at a greater heat than this the retort would burst. A fume or vapor will first appear to fill the retort; when this is the case, and the common air seems to be driven out, immerse the beak of the retort under a receiver, or to the foot of a gasometer, and the laughing gas will pass over. It should be collected over warm water, and before it is inhaled it should be suffered to remain in contact with water some hours, in order that it may become purified from any taint of nitrous gas that may be mixed with it. The annexed cut shows the arrangement of the apparatus convenient for the purpose of making it. This elastic fluid, usually called laughing gas, from the singular effects it produces on the human frame, when breathed for a short time, exciting pleasurable sensations, and frequently an uncontrollable disposition to laughter. It seems to act like wine or spirits, causing some degree of intoxication, but without the subsequent exhaustion and debility *occasioned* by strong liquors taken to excess. The continued use of nitrous oxyde, however, must be very injurious, since animals confined in this gas soon die.

Fig. 532.

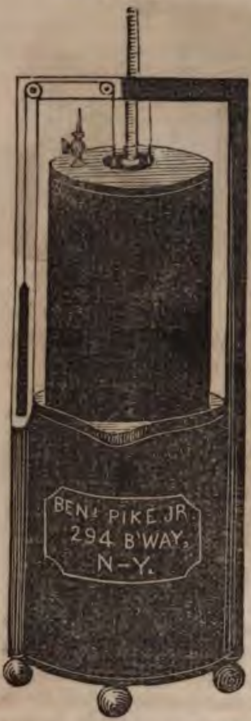


To procure Oxygen from Black Oxyde of Manganese.—(Fig. 532.)—Put into an iron retort half a pound of the black oxyde of manganese in powder. Place it in the fire, and when approaching a red heat oxygen gas will begin to pass out at the open end, as may be known by the increased flame of a candle held to it. When this is the case, fasten a collapsed bladder to the open end of the barrel, so as to be air-tight, when the gas will pass into it, and may be preserved for use. This quantity of oxyde should make about two gallons and a half of gas; it is not perfectly pure, but sufficiently so for ordinary experiments. Instead of the bladder, convey the liberated gas either to a gas-holder, or to glass-receivers, placed upon the shelf of the pneumatic trough for its reception.

To procure Oxygen from Chlorate of Potash.—A more convenient mode of preparing oxygen gas, is to put in a glass retort, or flask, having a bent tube, a quantity of chlorate of potash, mixing with it about one-fourth part of black oxyde of manganese, and apply the heat of a spirit lamp; when the gas will be freely disengaged, and may be collected beneath a bell glass upon a pneumatic trough, or received directly into a flexible gas bag.

The Gasometer.—(Fig. 533, next page.)—The gasometer is usually made of japanned tin or copper. It consists of an outer circular vessel, to the sides of which are fastened two round tubes, running upright, and about double the height of the vessel below. Across the top of these tubes is fixed a similar one that is square, which has a hole in the centre, and is furnished with two small pulleys near this hole, one on

Fig. 533.

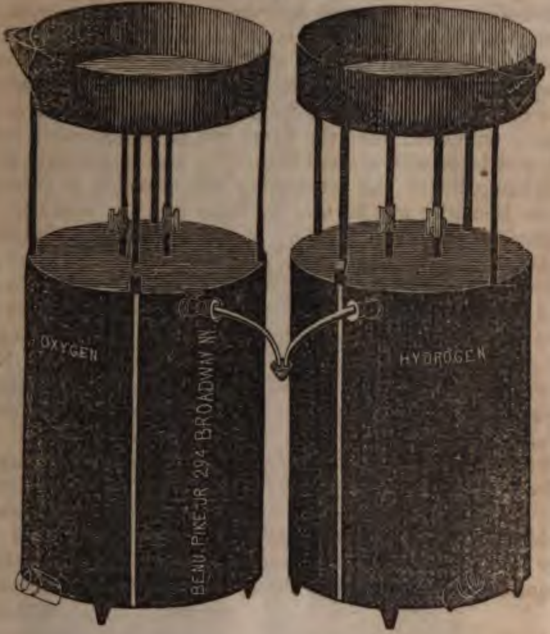


each end of it; and also two similar pulleys exactly at the corners. These are wholly hid from observation by the tube when the machine is finished, but the internal arrangement of these, on one side, may be seen in the cut. A little smaller than the vessel described above is another, made so as to pass very easily up and down in it. To the centre of this second vessel in the top is fixed a rod, which may be graduated, to show the quantity of gas within the gasometer from time to time. This rod passes through the cross-bar at top. Near where the rod is fixed, are two staples, having each a string to it, which passes over the two pulleys of its own side, and supports a weight at the other end. Thus it will be seen that the side tubes contain two weights, which should be such as exactly to counterbalance the vessel to which they are suspended. A stop-cock is fastened in the top to let out the gas, when wanted for use, into jars, bladders, or other apparatus. This cock will also admit the gas into the receiver from the apparatus, where it is being liberated. To use the gasometer, first let the inner vessel fall to the bottom of the outer vessel, and fill the latter with water. Then open the cock, and fasten it to the tube that conveys the gas from the retort. The gas rises, and gradually fills and lifts up the cylinder; and when sufficiently filled, the cock by which it entered must be closed. The gas may afterwards be drawn off as wanted.

Price, $10.00 to $20.00.

Compound Blow-Pipe.—(Fig. 534, next page.)—The compound blow-pipe consists of two separate reservoirs, or gas holders, each having at the bottom a neck, for introducing

Fig. 534.


OXYGEN
BENJ. PIKE JR 294 BROADWAY NY.
HYDROGEN

the neck of a retort, or a tube for filling with gas; and over the top, supported by four rods, a reservoir with open top, to supply the gas holder with water as it is consumed, and also to form a pressure on the gas. The reservoir and gas holder are connected by two tubes with stop-cocks; one of the tubes just entering the gas holder, the other passing down nearly to the bottom. The first is to be opened in filling the gas holder with water, and the other to form the pressure on the gas in its discharge; care being taken to supply the reservoir with water as it may be required. At the side near the top of each gas holder, is screwed a brass stop-cock, connected together by tubes branching out and terminating in one jet, in which the gases meet.

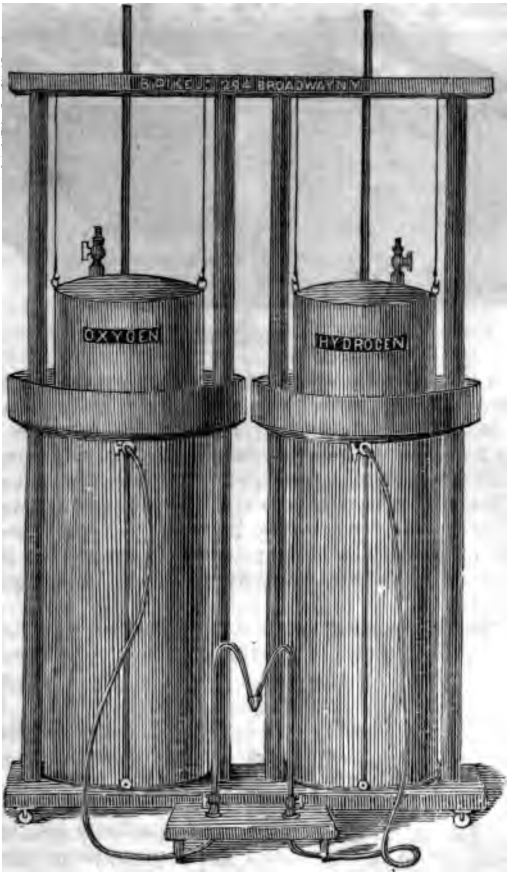
At the sides of each gas holder, there are cavities containing stout glass tubes, connected at both ends with the interior, for showing the exact quantity of gas contained in

the gas holders at any time. To use; having filled the gas-holders, the one with hydrogen and the other with oxygen gas, fill the reservoirs on top nearly full of water, and open the stop-cock that it may press on the gas; turn the stop-cock connected with the hydrogen gas holder, and set the gas on fire as it issues from the jet; the oxygen is then slowly admitted, when the flame will be considerably reduced, and burn with a small blue light, and apparently to the eye incapable of the astonishing effects which it produces, as an iron wire will burn in its flame with the readiness of a thread in a common candle. Procure a number of different substances, as lime, chalk, pieces of pipe stem, clay, the different metals, which may be about the size of half a pea, and place them in a cavity in a piece of charcoal, and subject them to the action of the flame; the lime will cause a most intense light, insupportable to the naked eye. Platinum, which cannot be melted in any furnace, will be readily fused and dissipate in vapor. Copper burns with a beautiful blue flame. Cast-iron, with bright sparks; and steel wire, watch spring, with brilliant scintillations; the calorific effects are only surpassed by a powerful galvanic battery. The gas holders are made of stout tin, handsomely japanned, holding about ten gallons each, but may be made of copper for about one half additional price, and larger size if required. Price, in japanned tin, $15.00.
" copper, - $20.00.

Compound Blow-Pipe, with Sliding Receivers.—(Fig. 535, next page.)—This convenient arrangement of the compound blow-pipe, may be understood by reference to the gasometer, previously described (Fig. 533). The receivers as there described, are suspended by cords passing over pulleys in the top of the frame, and balanced by weights contained in the upright tubes. The vessels are made of japanned tin, or copper, of about fifteen gallons capacity; the fixtures are of brass; the whole mounted on a wooden base and castors.

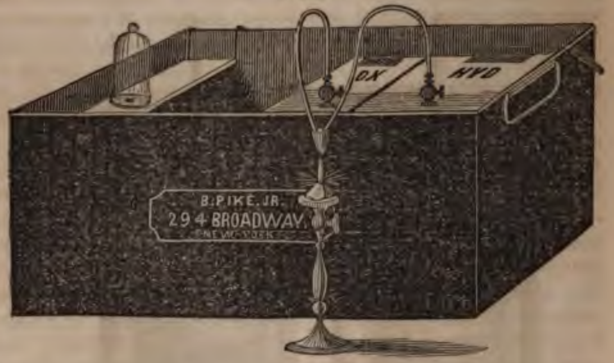
Price, in japanned tin, - - - - $30.
" " " with flexible tubes and jet, $40.
" in copper, - - - - - - $40.
" " " " " " $50.

Fig. 535.


B. PIKE & S 294 BROADWAY N.Y.
OXYGEN
HYDROGEN

Compound Blow-pipe and Pneumatic Cistern.—(Fig. 536, next page.)—The compound blow-pipe with pneumatic cistern combined, consists of a stout oblong cistern having two gas holders in the form of square boxes; the one for hydrogen being the largest. The gas holders are confined in their places by being slid under projections on the sides of the cistern, so that they cannot rise when filled with gas, and

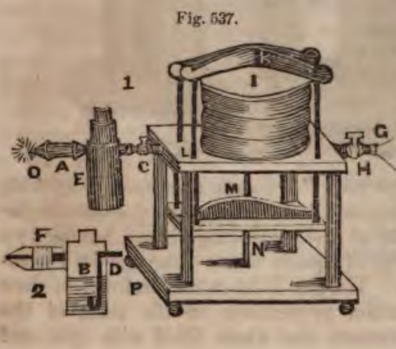
Fig. 536.



have on the top, stop-cocks, with a jet pipe uniting them, having tubes and screws for attaching. There is also a movable shelf for supporting bell-glasses, receivers, &c., having a short funnel on the under side for conveying the gas from the neck of a retort, or tube, into the bell-glass, &c. The gas holders may be filled by setting on this shelf, or by introducing a small tube beneath. They are made of tin, japanned, and also of copper, usually twenty-two inches long, twelve wide, and twelve deep, and also holding twice these contents.

Price, in japanned tin,	$ 8.50;	extra large,	$12.00.
" in copper,	$12.00;	" "	$18.00.
" stand for charcoal,			$ 1.50.

Fig. 537.

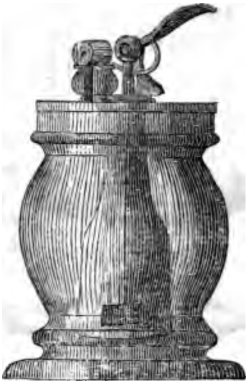


Gurney's Oxyhydrogen Blow-pipe.—(Fig. 537.)—A compact, powerful, and perfectly *safe*, instrument, for procuring a constant and intensely powerful flame, applicable to the usual purposes of a blow-pipe; that is, the melting of small quantities of refractory or difficultly fusible substances. The cut represents the apparatus complete. A and E (fig. 1) is the safe apparatus, a section of which is seen in fig. 2, and through which the gas must pass from the gasometer, through the stop-cock C, G is a transferring bladder, screwed to the stop-cock, H, by which the gasometer is charged by an assistant during its action, and such a quantity of gas supplied as to keep up a flame for any requisite time. Between the gasometer and the charging bladder a valve is placed, to prevent a return of the gas. I, a wood or pasteboard cap, so contrived as to unite lightness with strength; this is attached by four strings, K, to wires, which passing through holes, L L, in the table of the instrument, are fixed to M, a movable press-board below. When the requisite pressure or weight is placed on M, the cap, I, is drawn down horizontally and equally on the gasometer, D; upon which the gas (this is oxygen and hydrogen mixed together in the proportion of one part of the former to two of the latter) is forced through the water-tube, B, the safety apparatus, A, and out of the jet, C, at the end of which it is burned. In fig. 2, the gas enters B, passes through the water at D, then through a series of wire gauzes at E, and afterwards out at the jet.

Price, $18.00.

Hydrogen Lamp.—(Fig. 538.)—The hydrogen lamp consists of a glass vessel, into which a smaller one with open bottom, and having a small neck, is inverted; the neck being cemented into the socket of a brass plate covering the outer vessel. On the top of the plate is a stop-cock, with spring and lever to open at the side, to throw the hydrogen when made, on some spongy platina supported in a small box in front of the jet.

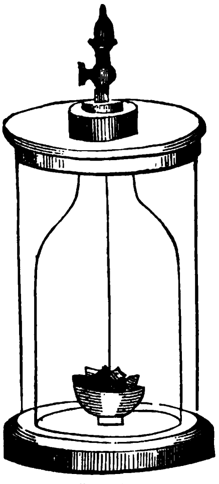
Fig. 538.



To charge the instrument, the outer vessel is nearly filled with water, previously mixed with one-tenth the quantity of sulphuric acid; a piece of zinc is supported on a brass rod fixed to the centre of the plate, and

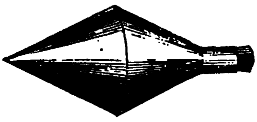
suspended just above the lower edge of the inner vessel. Hydrogen will now be generated, and rising in the inner vessel, expel the acid till it is below the surface of the zinc, when no more hydrogen is formed. To procure a light, turn the stop-cock, and the hydrogen will pass out in a very minute stream upon the platina; this will become red hot, and the hydrogen jet be inflamed—a match or candle may then be lighted by it. As the gas burns, the pressure is removed, the water again sinks, acts upon the zinc, and forms gas a second time, and so on till the whole is consumed. This instrument is sure and quick in its action, and is extremely valuable as a blow-pipe for chemical analysis, and when made large particularly for working in glass.
Price, $2.00; $3.00; $4.00.

Fig. 539.



Hydrogen Gas Generator.—(Fig. 539.)—This represents nearly the same apparatus as the last, of a larger construction, producing and containing a greater quantity of gas, and particularly useful in chemical experiments where a supply of hydrogen is required. On the top of the plate there is a stop-cock of the usual size of the cocks in chemical apparatus, having a brass jet for burning the gas. Price, $4.00 and $6.00.

Fig. 540.



Hydrogen Gas Pistol.—(Fig. 540.)—This consists of a vessel in the form of a double cone, soldered together, and having a neck at one end about one inch in diameter; on the surface of the opposite cone, is a small hole. Fill the vessel with hydrogen gas, and apply the flame of a candle to the small hole, the hydrogen will take fire and burn with a peculiar flame, and from its lightness will occupy the upper parts of the vessel, and the air pressing in below will mix with the gas. Invert the vessel slowly, and the mixture will explode with a loud report. Price, 38 cts.

Fig. 541.

Air Balloons.—(Fig. 541.)—The air-balloon consists of a light bag, formed of goldbeater's skin, of a globular or elliptic shape, and rendered air-tight by a coating of varnish. When thus prepared, it must be distended with some elastic fluid, lighter than common air, as hydrogen, and it will thence acquire an ascending power, equal to the difference between its weight, including the attached car and its contents, and that of the bulk of atmospheric air which it displaces.

Price, 12 in. long, 56 cts.; 15-in. 75cts.
" 18 in. $1.25; 27 in. $1.75;
" 32 in. $2.50; 36 in. $3.25.

Fig. 542.

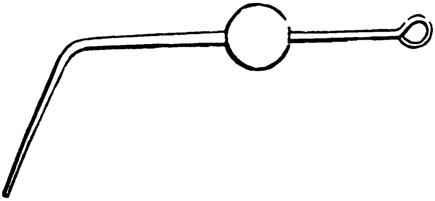
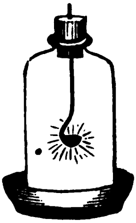


Fig. 543.



Ether Jet.—(Fig. 542, as above.)—This is an oblong spherical bulb with a long carved jet on one end, and a handle to hold by at the other; it is filled by warming the ball, and then immersing the jet in ether; on cooling, the ether will fill the ball. If it now be suffered to boil by the heat of a lamp, the ether may be set on fire as it is forced out of the vessel by the pressure of its vapor. It burns in a beautiful arch of great brilliancy; if alcohol be substituted for ether, the light is less brilliant, showing that different vapors and gases evolve different quantities of light when ignited.

Price, in glass, $0.38.
" in metal, $1.00.

Deflagrating Jar and Spoon.—(Fig. 543, as above.)—The first is a glass jar, with a large opening at the top for the insertion of a cork or stopper, through which is thrust in some experiments a metal spoon, shaped as in the cut;

in other experiments a coiled wire, a piece of charcoal, &c. The whole is intended to show that oxygen and other gases are supporters of combustion. Sometimes the mouth of the deflagrating jar is ground flat, that it may be covered with a piece of plate glass. Price, 75 cts. to $1.50.

Fig. 544.

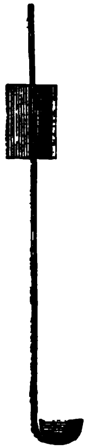


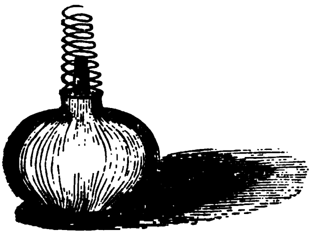
Fig. 545.

Deflagrating Ladle.—(Fig. 544.)—This cut represents a deflagrating ladle for burning small portions of phosphorus, sulphur, &c., in oxygen gas. It is attached to a cork, fitting the neck of a bell glass. Price, 25cts.

Davy's Safety Lamp.—(Fig. 545.)—An instrument to prevent the fatal explosion of fire damp, to which miners are exposed when working in coal mines; it is constructed on the principle that flame will not penetrate a fine wire gauze, and consists of a lamp of brass or tin, having a stout wire frame, at the top of which is a plate and ring by which the lamp is held; within the wire frame is a cylinder of wire gauze inclosing the flame, but permitting a sufficiency of light to pass through; at the side is a feeder for oil, and there is passing through the bottom a wire to pick the wick.

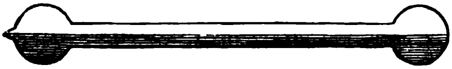
Price, of best brass mounted, $5.00.
“ of plainer, - - $3.00.
“ of tin, - - $2.00.

Fig. 546.



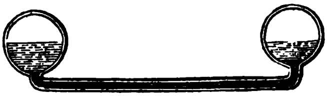
Flameless Lamp.—(Fig. 546.)—The aphlogistic, or flameless lamp, having a glass instead of metal tube for supporting the wick; a fine platina wire about fifteen inches long, and wound in the form of a spiral spring, is placed partly over the end of the wick. The lamp thus prepared is filled with alcohol, and the lamp lighted, which will heat the wire red hot if properly arranged; blow the flame out, and the wire will continue red hot as long as any alcohol remains in the lamp. Price, $1.25.

Fig. 547.



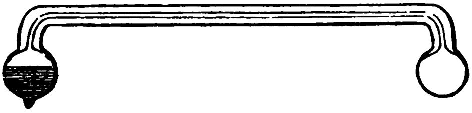
Pulse Glass.—(Fig. 547, as above.)—A little instrument to show the effects of heat. It consists of a small glass tube, with a bulb at each end, and partly filled with colored spirits of wine, the space above the spirit being void of air. When this tube is held in the hand obliquely, a small bubble of air remaining in the lower ball, the heat of the hand will expand the air in this bubble, and its escaping into the vacant space above with a pulsatory motion occasions the instrument to be called a pulse glass, though it has no reference to the state of the pulse. Price, 50cts.

Fig. 548.



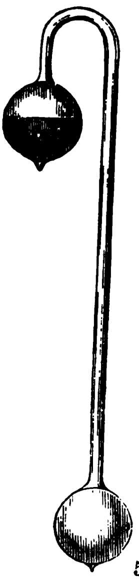
Boiling Glass.—If the glass be made in the shape of the annexed tube, the liquid will appear to boil rather than rise in pulsations. Price, 50 cts.

Fig. 549.



Chryopherus.—(Fig. 549.)—An instrument for illustrating the effect of evaporation in producing cold. It consists of a glass tube, from 18 inches to 2 feet in length, having an internal diameter of one-fourth of an inch. The tube is bent at right angles near the ends, both of which are terminated by bulbs, as in the above figure; or bent at one end only, as represented in Fig. 549, next page, which is the strongest and preferable form. In constructing this instrument, one of the bulbs is nearly filled with water, which being made to boil, the air is expelled from the tube and bulbs, which re-

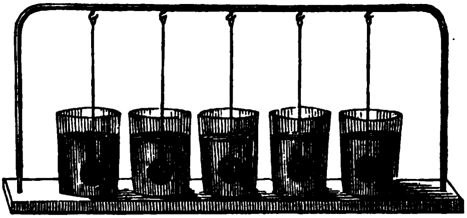
Fig. 549.



main filled with steam. The open bulb is then closed, by melting the glass at its capillary termination. When the empty bulb is immersed in a mixture of salt and snow, the vapor existing within it is condensed, which removing pressure from the surface of the water in the other bulb, enables it to evaporate rapidly; and the vapor being condensed as speedily as it is formed, the water is readily frozen.

Price, $1.75.

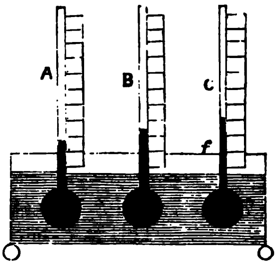
Fig. 550.



Apparatus for showing Specific Heat.—(Fig. 550.)—In this arrangement there is a wooden base supporting five glass tumblers, over which there is a metallic frame, having a hook over each tumbler, to each of which there is suspended near the bottom by a cord, a metallic ball; two of the balls are of iron, one of copper, one of tin, and one of lead, each weighing exactly half a pound. To use, they are to be suspended by their cords in boiling water, and each will be heated to 212 degrees; they are then quickly suspended in the separate tumblers, each containing exactly the same quantity of cold water, and all of the same temperature. As the quantity of water and the temperature in each vessel is the same, and the five balls of equal weight, we should suppose that the water would be equally heated, but we shall find that the lead will raise the temperature the least, the tin more, the copper more yet, and the iron most of all, each imparting a different quantity of heat, except the two iron balls, which will be alike. The heat imparted by each ball to the water in which it is immersed is called its specific heat.

Price, $4.00.

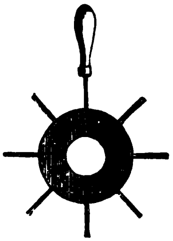
Fig. 551



Different Fluids Expand Unequally.—(Fig. 551.)—The apparatus for illustrating this experiment consists of three glass tubes with bulbs on their ends of exactly the same size, and filled with different liquids to the same height. A may be filled with alcohol, B with water, and C with sulphuric acid, to each is fixed a scale; they are suspended in a tin trough, and when hot water is poured in, the fluids will be found to rise to different heights, according to their expansibility; the alcohol will be the highest, the water next.

Price, with 16-inch tubes, $4.00.

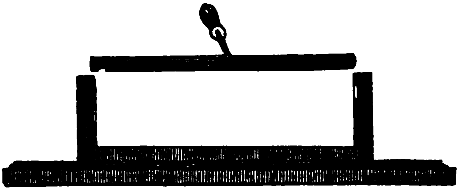
Fig. 552.



The Conductometer.—(Fig. 552.)—The conductometer is an instrument for illustrating the relative conducting power of different metals, and consists of a circular plate of brass, with a hole in the centre, the edge perforated with holes into which are inserted rods of different metals, of the same size and length, each having a small cavity in its extremity for holding a piece of phosphorus; on holding the plate over the flame of a spirit lamp, the heat will be conducted along the different metallic rods, inflaming the phosphorus first in that which is the best conductor, and in the others according to their conductibility. The arrangement usually is copper, brass, iron, tin, zinc, lead, and glass. Price, $1.75.

Expansion of Metal by Heat.—(Fig. 553, next page.)—This instrument consists of a cylindrical piece of iron, having a handle adapted to it, and fitted to a piece of metal having the ends bent up, so that it may just pass through lengthwise, and at its ends go through a round hole; when heated in the fire, it will be too long to pass in one direction, and too thick to pass in the other. Having become cold, it will again fit and pass through as before. The metallic plate is *supported* on a mahogany base. Price, $1.50.

Fig. 553.



The Ring and Ball to show Expansion by Heat.—(Fig. 554, as below.)—This is a very elegant way of showing the same experiment as the last. It consists of a brass ball, suspended from a brass pillar bent over at the top; on the pillar slides an arm bearing a brass ring, exactly fitting the ball, and which when cold will readily pass through; on heating the ball, by a small spirit lamp, it will be too large to pass through; when cooled it will pass as before. The whole is mounted on a neat mahogany base. Price, $2.25.

Fig. 554.

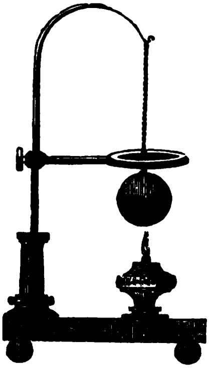
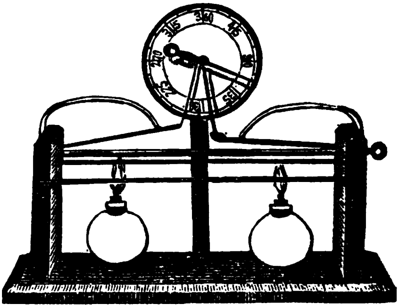


Fig. 555.



Pyrometer.—(Fig. 555, as above.)—This arrangement consists of a base of mahogany about twelve inches long, to which are attached two upright pieces which are immovably held in their position by metallic braces, extending from the one to the other; between these there is a rod of metal, supported at one end from the point of a screw, and at the other from the shorter end of a bent lever, the axis of which is fastened to the wood. The longer end of the lever is connected with a cord, which passes round a wheel on the centre of an index, to another lever on the opposite side, intended to balance the first lever. Over these levers are springs, to keep the cord tight. The index and wheel on which the cord moves is fixed to an upright support, having a graduated brass ring, divided, and numbered on its face from 0 to 360. A rod of any metal, the expansion of which is to be tried, is put between the point of the screw and the lever, as before described, and as soon as the heat of the spirit lamps beneath is applied the metal will begin to expand, and its comparative degree of expansibility will be shown by the distance to which the index moves, as noted on the graduated circle. In comparing different metals with this, it will be necessary to make the rods of the same size, and apply the heat of the lamps the same length of time.

Price, $3.50.

Fire Syringe.—(Fig. 556.)—This instrument is used for procuring an instantaneous light, by means of the condensation of air. It consists of a stout condensing syringe, having a solid piston with a hole, for containing a small piece of tinder, at the end. Upon forcing down the piston quickly, the air within the tube is rapidly condensed, and the condensation occasions so great an evolution of heat as to light the tinder.

Price, $1.00.

A larger and more elegant article (Fig. 557) with glass cylinder for showing the flash of light accompanying the ignition. Price, $6.00.

Caloric conducted slowly by Fluids downwards.—(Fig. 558, next page.)—This apparatus, to show that caloric is conducted by fluids slowly in a downward direction, consists of a funnel-shaped glass vessel, having an air thermometer, with a ball of consider-

Fig. 557.

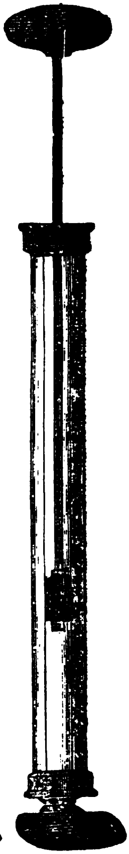


Fig. 556.

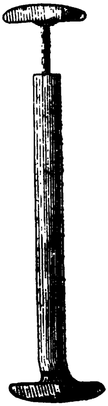
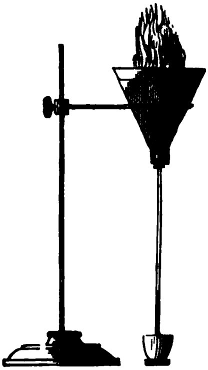


Fig. 558.

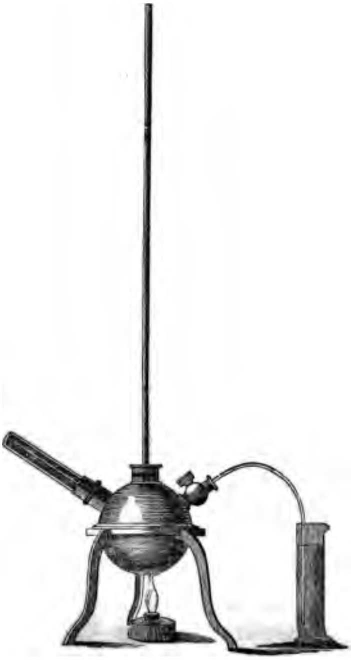


able size, and fixed in the lower part of the funnel, the tube projecting through and containing a few drops of colored alcohol, and dipping into a cup containing the same liquid. To use, pour water into the funnel till it covers the bulb of the thermometer to the depth of half an inch, and upon the surface pour a small quantity of ether and set fire to it. Much heat is given out in the combustion of the ether, yet the water will not transmit it downwards in a sufficient quantity to affect the thermometer.

The experiment may be varied by suspending above the flame of the ether, a glass or metallic vessel, containing the same quantity of water as the funnel, which will be found, after the ether is burnt, to have received a much greater quantity of heat than the lower one, as the thermometer will indicate.

Price, - - $0.75.
" with stand, $1.75.

Fig. 559.

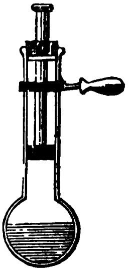


Steam Boiler.—(Fig. 559.)—This neat apparatus, called the high pressure boiler, shows in a very lucid manner, the properties of steam, when under more than ordinary pressure. It consists of a strong brass globe or boiler, having a long and strong glass tube open at both ends, passing through a stuffing box, air-tight in the top of the boiler; and extending to the bottom on one side there is a thermometer also passing through a stuffing box, air-tight, the ball within the boiler, and the scale on the outside, which has a stout glass shade to protect it from being broken; on the other side of the boiler there is a stop-cock with a pipe that may be disconnected; the boiler is supported on a brass stand, and the heat is applied by means of a large spirit lamp beneath. To use, a small quantity of mercury, about half a pound, is poured in, and the boiler about half filled with water, leaving the stop-cock open; heat the globe with the lamp till the steam issues from the pipe, when the thermometer will stand at 212°, but will immediately begin to rise, forcing the mercury up into the glass tube, and when it has reached the height of thirty inches, or the pressure of an additional atmosphere, the water will be heated to a temperature of 250°. Pour half a pound of water into the boiler, and apply the heat till all is converted into steam, having the pipe immersed in a vessel containing five pounds of water, at 60°, it will raise the temperature of the five pounds to 160°, or will boil a smaller quantity.

Price, $15.00.

Wollaston's Steam Apparatus.—(Fig. 560.)—Is a small but neat contrivance of Dr. Wollaston, to illustrate the principle of the condensing steam engine. It is represented annexed, and consists of a glass flask fitted with a belt outside, and handle screwed to the belt. Inside it has a solid piston, working with little friction, yet steam-tight, up and down. A little water or ether is placed in the bulb of the flask and made to boil; the piston is then put in, and the bulb being dipped for a moment in cold water, the steam withinside condenses, and the piston descends; making the liquid boil a second time drives up the piston, &c.; thus the piston rises at every formation, and falls at every condensation of the steam.

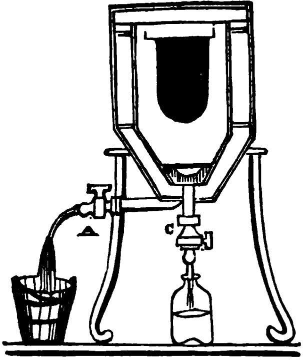
Fig. 560.



Price, $1.50.

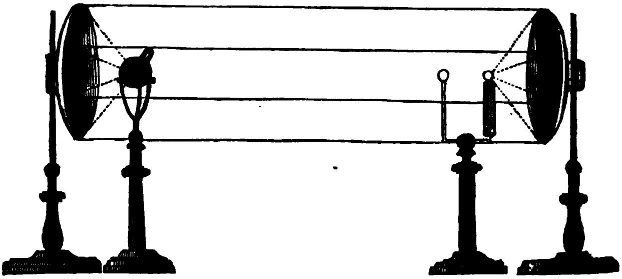
Calorimeter.—(Fig. 561, next page,)—An instrument for measuring the quantity of heat contained in any body, the temperature of which is above thirty-two degrees. It con-

Fig. 561.



sists of two metallic vessels, placed one within the other, with a space between them; each vessel being furnished with a stop-cock at bottom. The vessels have each a closely fitting cover, which covers have also a space between them. If the space between the vessels be filled with melting ice or snow, this will gradually melt away, and the water formed run out by the cock, A; by this arrangement the temperature of the inner vessel will always be that of the freezing point, or the thawing point, which is the same thing. A third vessel, B, is now placed within the second, and the space between the two inner vessels also filled with melting ice. It is evident that the ice contained in the second vessel, cannot be affected by the external air; therefore, when a heated substance is placed within B, it will melt a certain proportion of the inner stratum of ice, the quantity of which melted, and consequently the quantity of heat parted with, to lower it to 32°, is ascertained by the quantity of water which flows out of C. Price, $8.00.

Fig. 562.



Reflectors, &c., for Radiation of Heat.—(Fig. 562.)—Reflectors arranged for the radiation of heat, commonly called *Pictet's Apparatus*, consist of two concave reflectors, or mirrors of brass, or planished tin, twelve inches or more *in diameter*, and mounted on mahogany stands, having rods, n which they slide up and down; there is an iron ball, bout three inches in diameter, having a ring in it for more onvenient handling, and having a stand supporting it pposite the centre of the mirrors, and also a differential ermometer, supported by a mahogany stand.

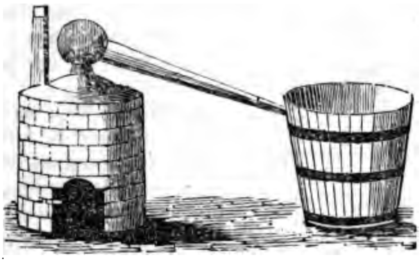
To use, place the mirrors at the same height, on a table, actly facing each other, and from ten to fifteen feet apart. nd in the focus of one of the mirrors (usually four and a alf to five inches) place the iron ball, heated a little below dness, and in the focus of the other mirror, place the ermometer, which will indicate a considerable elevation of mperature. Place a piece of phosphorus in the focus of e mirror, and it will be ignited.

The rays of heat from the iron fall on the nearest mirror nd are reflected in a direction parallel to the axis of the irrors; they then meet the second mirror, and are con-entrated on the thermometer, or phosphorus, in the focus f the mirror. Care must be taken to have the mirrors rranged in a common axis.

Price, of 12-inch planished tin, with iron ball stands and differential thermometer,	$ 8.00.
" of 12-inch brass, - - - -	$20.00.
" of 18-inch, " - - - - -	$32.00.

Leslie's experiment of a vessel on a stand having different radiating surfaces. Price, $1.50.

Fig. 563.

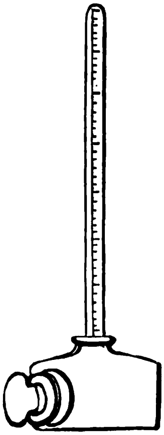


The Still.—(Fig. 563.)—An apparatus for the distillation of liquids. It includes the body, or boiler, to which is attached the head, forming the communication between the boiler and condenser, or worm-pipe, from the extremity of which the distilled liquid passes in successive drops, or a small continuous stream. As these stills are made to act by means *of a lamp*, the whole process of dis-illation *may be performed* on the table, without dirt, offen-

313782

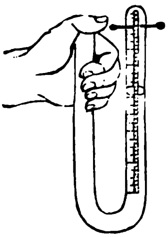
sive smell, or other inconveniences. Aromatic waters and essential oils may thus be obtained from lavender, roses, and other plants and flowers; and alcohol and brandy may be distilled from wines, cider, &c. They are usually made of copper, the boiler holding from one quart to a gallon.
Price, $6.00 to $8.00.

Fig. 564.



Hope's Eudiometer (Fig. 564) consists of a glass bottle, holding about a gill, having a stopper in its side; and a glass tube closed at one end, and ground into the neck of the bottle at the other end. The tube is graduated into 100 parts. It is used in the examination of gases, atmospheric air, &c. Its mode of use is, to fill the graduated tube with the gas to be tried, and filling the bottle with some solution, capable of absorbing the gas, or one of the gases, if a mixed gas, as the atmospheric. The oxygen may be absorbed and its amount indicated by opening the stopper in the side under water, when the liquid will rise in the tube. Price, $2.50.

Fig. 565.



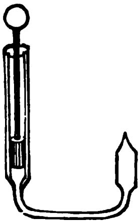
Ure's Eudiometer (Fig. 565) consists of a glass tube bent in a U form and closed at one end, the closed tube being graduated into 100 equal parts, and having inserted near the end, two platina wires, the outer extremities being formed into rings, or small balls for the passage of an electric spark.

In the analysis of atmospheric air, a known quantity is introduced, and to it added a like quantity of hydrogen gas; the remainder of the graduated tube, bend, and a portion of the open tube being occupied with water. The thumb is placed on the open end of the tube, and the gases exploded by the passage of an electric spark between the platina wires. The quantity of gas left is then ascertained, and deducted from the original quantity, one-third of the remainder being the quantity of oxygen contained in the atmospheric air examined. Price, $4.00.

y's Gas Transferrer.—(Fig. 566.)—A instrument for the conveyance of a uantity of gas from one vessel to ano- It consists of a glass tube, shaped as cut, both ends being open, and one of rawn to a fine point. A tight piston d fits into the straight part of the tube. e parts of the instrument below the pis- filled with mercury. To use the in- nt, immerse it in a jar of gas, by passing int upwards through the mercury in rcurial trough. Draw up the piston, which will draw mercury also, and suffer the gas to enter the point transferrer. When enough gas has entered, depress int below the surface of the mercury, and elevate the a very little to draw a globule of mercury into the ifice. When this has been done, the instrument may en out, and the gas it contains be carried where it e required.

Price, 75 cts.

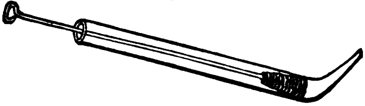
Fig. 566.



s Syringe.—(Fig. -This instrument ed of a piece of t glass tube drawn end to a point, a piston packed with tow attached to a wire handle. ans of this instrument a globule, or small quantity, e drawn into the tube, and transferred to any ressel.

Price, 75 cts.

Fig. 567.



aratus to show the Condensation of Liquids by re.—(Fig. 568.)—This consists of a tube of having a double globe, as represented in the To use it, fill the tube and one ball with one as water, and the other ball with another, as l, sulphuric acid, &c.; cork it and turn it down. The diminution of volume when the e mixed together will be seen in the tube.

Price, $1.25 to $3.00.

Fig. 568.

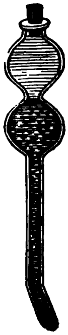
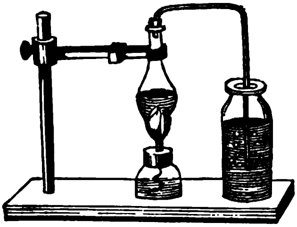
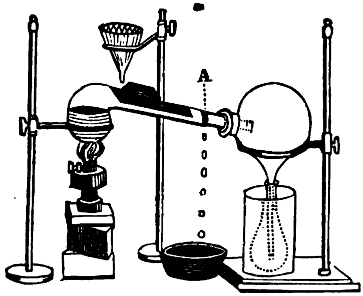


Fig. 569.



The Tube and Flask Holder.—(Fig. 569.)—This consists of a metal rod supported on a mahogany or metal stand; on the rod is a movable ring, having a milled-head screw by which it may be fastened at any height; on the side of the ring opposite to the screw is a pair of spring forceps, so formed as to receive the necks of various sized flasks, tubes, &c., and by the drawing of a slide on the forceps the flask or tube may be conveniently held. The cut represents a flask thus supported, having a bent tube connected to the neck of the flask by a cork through which the tube passes, the other end of the tube being immersed in a jar of water; a spirit lamp is placed under the flask. Price, $1.50.

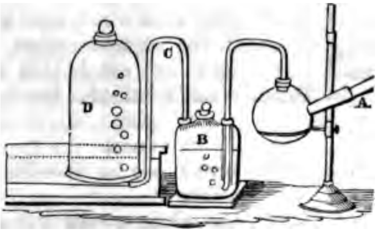
Fig. 570.



Apparatus for Distillation and Condensation of Liquids.—(Fig. 570.)—This arrangement consists of a glass retort supported on a common retort stand by one of the rings; a spirit lamp beneath: a retort stand supporting a tubulated quilled receiver, the neck of the retort entering the tubular neck of the receiver, the quilled neck of the receiver being inserted into a flask surrounded by a jar of cold water; another retort stand supporting a funnel of water, which by drops falls on folds of paper on the neck of the retort, and from thence dropping into a bowl beneath. In the distillation of some ether the annexed cut will assist the understanding of several means of condensation. The ether passing from the retort meets first with water trickling from a funnel and falling upon folds of bibulous paper placed over the stem of the retort. A little further down the neck, water drops from a vessel at A on the neck, and from that to a vessel beneath; then passing into a tubulated receiver, it is partly cooled by the air striking the sides of the receiver. Finally, the liquid falls into the flask beneath, this flask being inserted into a vessel of water.

Price, with three retort stands and spirit lamp, $6.00.

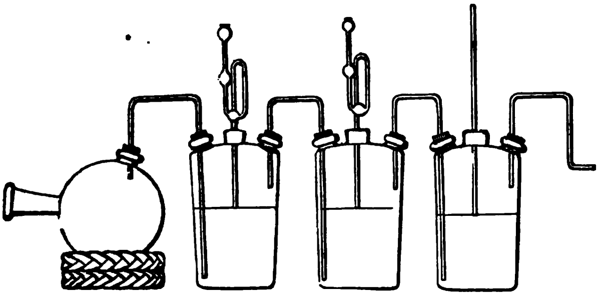
Fig. 571.



Apparatus for the Condensation of Gases.—(Fig. 571.)—Consists of a tubulated receiver, supported on a retort stand, at one of the necks having a bent tube, which enters one of the necks of a three necked bottle, passing down nearly to the bottom; the opposite neck having a bent tube for passing the gas into a bell glass. This apparatus, as arranged in the production of nitrogen from chlorine and ammonia, is represented in the cut. The open pipe at the side is supposed to be the beak of a retort in which chlorine is being disengaged. It enters the globular receiver and deposits condensed vapors. Then passing along the bent tube, it arrives at the bottle, B, which is partly filled with diluted liquid ammonia; passing through the ammonia, it is conveyed away by the pipe, C, into the jar, D.

Price, with retort stand, $3.50.

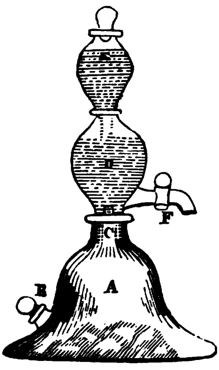
Fig. 572.



Woolf's Apparatus.—(Fig. 572, as above.)—The most elegant and convenient method of impregnating water with an absorbable gas is by means of Woolf's apparatus, which consists of a series of glass three-necked bottles, connected together by bent glass tubes; the arrangement is shown in the figure. The gas issues from the retort, the neck of which enters the tubulated receiver, and from thence passes into the water in the first bottle and is absorbed; when the water in this vessel is saturated, the gas passes to the next vessel by the glass tube which dips beneath the water; this being saturated, the superabundant gas passes to a third vessel, and so on to any extent that may be required.

Price, Woolf's half-pint bottles, - -	$0.75.
" " pint " - -	$1.00.
" " quart " - each,	$1.25.
" bent tubes for Woolf's bottles, each,	$0.25.
" safety " " " " "	$0.75.
" the whole arranged in a tray, ½ pint,	$6.00.
" " " " pint,	$6.50.
" " " " quart,	$7.50.

Fig. 573.

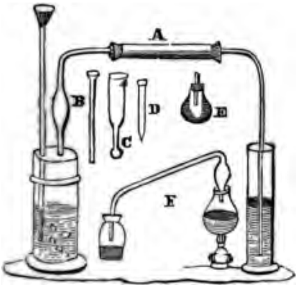


Nooth's Apparatus.—(Fig. 573.)—There are various kinds of apparatus for impregnating water with carbonic acid. One of the most elegant and simple is Dr. Nooth's, represented in the cut.

The upper vessel, E, is shaped like a funnel contracted at the top, and covered by a stopper, which, however, does not fit tight; the middle vessel, D, fits into the lower one, A, and a communication is made from one to the other by a tube, C, between them, which tube is perforated by holes so small, that gas will ascend through them, but water will not descend. The lower vessel, A, contains chalk and water. To use the apparatus, fill B with water, then partly fill E also with water, and put them in their appointed places upon each other; then pour sulphuric acid into the orifice, B, carbonic acid gas will rise, pass through C, and be absorbed by the water in D. When more gas arises than can be absorbed, its pressure above the surface of the water in D will drive a portion of that water up into the funnel at top, E, and thus the safety of the apparatus is insured.

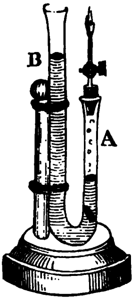
When the aerated water is required for use, it is drawn off by the tap, F. Price, $15 to $20.

Fig. 574



Christison's Apparatus for detecting Poisons.—(Fig. 574.) A is an instrument for reducing the sulphurets of some of the metals by a stream of hydrogen gas. B is a funnel-shaped tube, for testing minute portions of liquids. C, a tube for reducing a small quantity of mercury. D, a tube for taking up a minute globule of ditto. E, bottle and tube for washing down scanty precipitates or filters. F, apparatus for the distillation of fluids, supposed to contain acids. Price, $4.00 to $5.00.

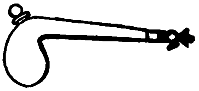
Fig. 575.



Marsh's Arsenic Apparatus.—(Fig. 575.)—This little instrument is effectual in detecting the most minute quantity of arsenic in any solution. It is composed of a bent glass tube, slightly widened at both ends, one area of it being three or four inches longer than the other. Into the shorter arm a small piece of zinc is dropped; a thread should be attached to it so that it shall not quite reach the bottom of the tube. The liquid suspected to contain arsenic has a little sulphuric acid mixed with it, and a portion is poured into the arm B. The stop-cock being open, the liquid will fully occupy A; but hydrogen gas being formed by the contact of the acid and zinc, this will ascend; and the stop-cock being closed. it will accumulate. Upon being let off and a light applied to the jet of the cock, the *arseniuretted* or common hydrogen, as the case may be, will be lighted; if it be the former, that is, if arsenic be present, it will tinge with a purplish metallic stain a piece of glass held close over it; with common hydrogen, no stain will be perceptible.

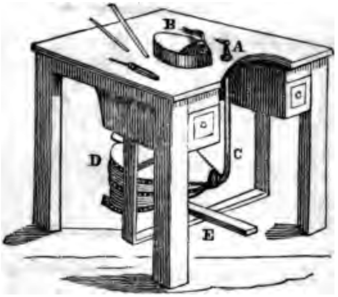
Price, $2.50.

Fig. 576.



Retort, with Cap and Stop-Cock.—(Fig. 576.)—Retorts with brass cap and stop-cock, by which the air may be extracted, and any gas introduced from a bell glass. Price, $1.50.

Fig. 577.



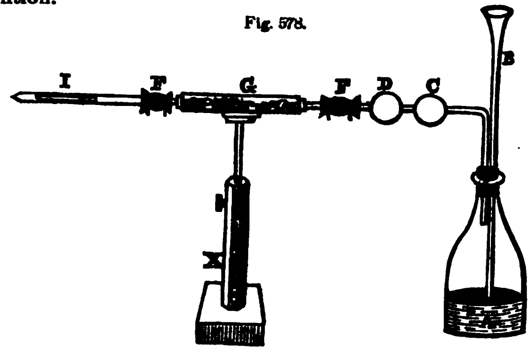
Glass Blower's Table.—(Fig. 577.)—This consists of a neat table with double bellows worked by a treadle, and having a pipe with a jet urging a stream of air through a powerful lamp, supplied with tallow, and is a very convenient article for the use of those who manufacture small articles in glass, such as thermometers, test tubes, ornamental objects, &c. The materials used are glass rods and tubes, of different colors and sizes. The apparatus is merely intended to produce a steady and intense heat, that the glass tubes may be softened in a manner proper for the artist to bend and blow them into the required form.

A is a jet of metal, through which the air issues into the flame of the lamp, B. The air is, by means of the treadle, E, forced into the double bellows, D, and driven up the pipe, C, until it issues from the jet. The whole is affixed to a table. The bellows is loaded at the top in proportion to the strength of the blast required. Price, $25.00.

Apparatus for Chemical Analysis.—For the greater number of analytical experiments on minerals, very simple apparatus will be found sufficient. Tubes, flasks, and evaporating basins, bottles, precipitating glasses, filters, funnels, dropping tubes, a silver, a platinum, and porcelain crucible, each capable of containing from a quarter to half an ounce, small retorts and receivers, a balance, a pair of forceps, a mortar, and a strong spirit lamp, constitute all that is necessary. A blow-pipe and set of test-tubes are of great use. A separate apparatus is also very desirable for the preparation of sulphuretted hydrogen gas, which is much employed in analytic operations.

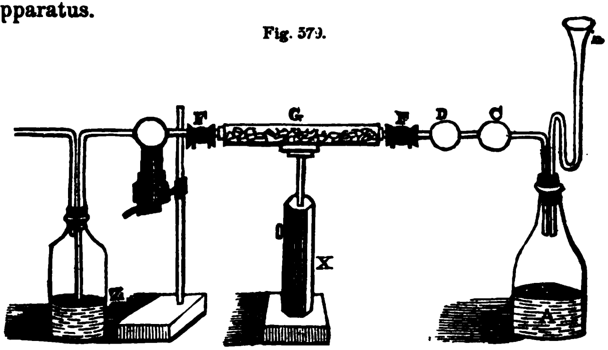
The three figures (Nos. 578, 579, and 580) represent the usual disposition of apparatus employed in preparing, drying, and transmitting gaseous substances over any subject of experiment, when the apparatus requires much care and attention.

Fig. 578.



(Fig. 578, as above), A, represents bottles, flasks, or retorts, for producing the gas required; B, a long funnel for introducing acid in small successive quantities, or any other liquid that may be required; C D, balls for intercepting any portion of fluid which may be mechanically suspended in the gas escaping from the bottle; G, the tube filled with fragments of chloride of calcium for drying the gas; F, caoutchouc connectors; X, wooden stands for supporting the apparatus.

Fig. 579.



In Fig. 579, the gas is made to act upon I. The assay is often placed in tubes, as G. This figure illustrates the arrangement adopted when a gas produced by the action of the assay, with the gas from A, is to be transmitted into water, a solution of potassa, or any other substance contained in the bottle Z.

Fig. 580.

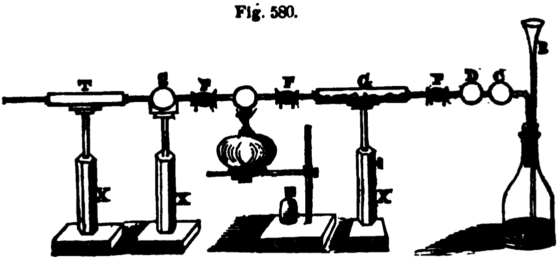


Fig. 580 represents a still more complicated arrangement, in which the product obtained, as in the preceding figure, is subjected to still further operations, by the materials introduced at S or T. A glass spirit-lamp, mounted on a movable arm, and rod attached to a foot, as represented at Z, is a convenient appendage.

Price, $2.50 to $10.00.

Fig 581.

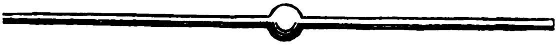


Fig. 581, one bulb tube. Price, 37½ cts.

Fig. 582

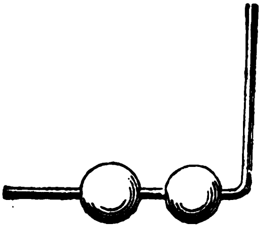
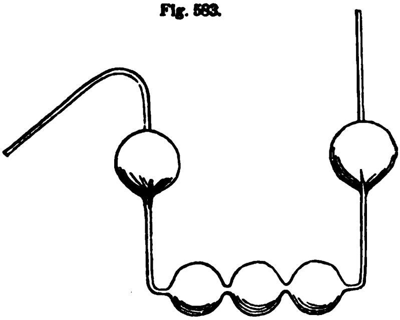


Fig. 582, two bulb tubes.
Price, 50 cts.

Fig. 583.



Five Bulb Potash Apparatus.—(Fig. 583, as above.)—This is a glass instrument with five bulbs, for containing solution of potash to absorb the carbonic acid produced in an analysis, made very light, of the shape of the cut, and also after Liebig's pattern. Price, $1.25.

Fig. 584.

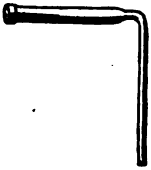
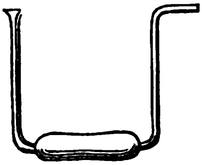


Fig. 585.



Drying Tubes.—(Figs. 584 and 585, as above.)—Bent tubes in which organic bodies are dried, used in organic analysis. Price, 37 to 75cts.

METEOROLOGICAL INSTRUMENTS.

THE THERMOMETER.

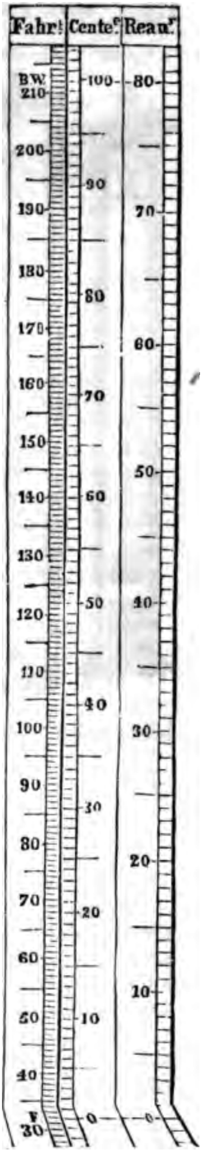
An instrument for determining the exact variations of heat or temperature. The principle on which they are constructed, is the change of volume which takes place in bodies when their temperature undergoes an alteration. The thermometer consists of a narrow glass tube having an uniform bore, with a bulb at one end, usually filled with mercury, so that expansion or contraction can only take place by the rise or fall of the mercury in the tube; the upper end of the tube is hermetically sealed, within which is a vacuum. The tube is usually fastened to a plate of metal which is graduated to form a scale; the rising of the mercury shows an increase of heat, and the falling a diminution of heat. The usual graduation of the thermometer is according to Fahrenheit; the 0 is called zero; at 32° water freezes; at 98° is blood heat; at 212° water boils. Reaumur's scale is used considerably in France; at 0 water freezes, and at 80° water boils. The scale that is used by philosophers in most parts of the world, and that required to be used in the academies of the State of New York by law, is the centigrade scale; its 0 is at the freezing point, and 100° at the boiling point of water. This scale is frequently graduated on one side of the thermometer tube and Fahrenheit's scale on the other. The thermometer is of extensive use not only to scientific men in their experiments, but is used for regulating the temperature of buildings, hothouses, baths, in the arts, and by navigators in determining the temperature of the water, informing them by its increased coldness of the vicinity of land, or when approaching the Gulf *Stream by its greater warmth.*

Common Thermometer.—(Fig. 586.)—The common case for the thermometer is of tin, japanned black, and varying in size from six to fourteen inches in length.

Price, 6 inch, $0.63.
" 7 " $0.75.
" 8 " $0.87.
" 10 " $1.00.
" 12 " $1.25.
" 14 " $1.50.

If with Reaumur's or centigrade scale, 25 cents in addition.

COMPARATIVE SCALE.



Pike's Improved Thermometer (Fig. 587) consists of a thermometer made as usual, but mounted on a mahogany back, with polished edges; the ball being protected by a brass guard, with holes or slits in it to allow the free circulation of air around the ball. This style of thermometer is much approved of and used by many in keeping meteorological observations. Price, 8 in., $1.00.
" 10 " $1.25.
" 12 " $1.50.
" 14 " $1.75.

With centigrade scale 25 cents in addition.

If with movable index, and Fahrenheit, and centigrade scale, 14 inches long, $2.50.

Fig. 586.

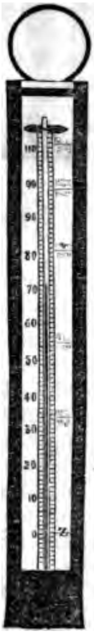


Fig. 587.

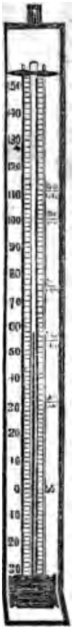


Fig. 588

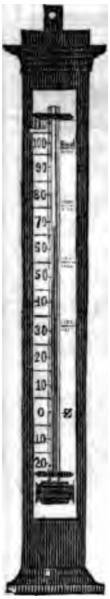


Fig. 589.

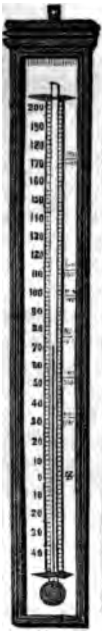
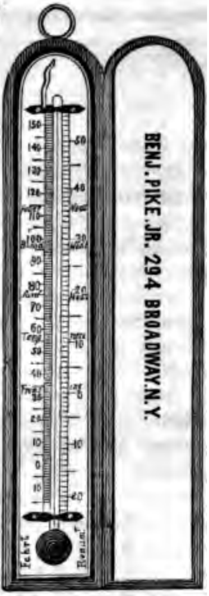


Fig. 590.


BENJ. PIKE JR. 294 BROADWAY.N.Y.

Ornamental Mahogany Framed Thermometer.—(Fig. 588.)—A very neat polished frame, inlaid round the scale with ebony, and the ball covered with a brass guard.

Price,
" 24 inch, $6.00.
" 18 " $2.50.
" 12 " $1.75.

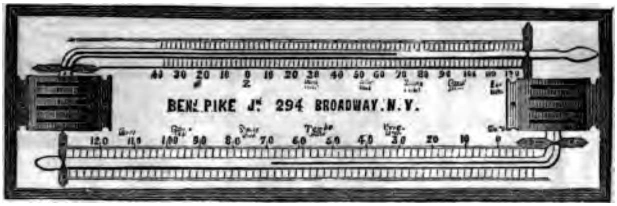
Mahogany Framed Thermometer, with Glass in front.—(Fig. 598.)—A neat frame of mahogany or rosewood, having a flat or circular glass in front of the plate, for protecting it from dust and the action of the weather, or otherwise being soiled.

Price, best 20 inch, with flat glass, $5.00.
" " " " with bent glass, $6.00.
" " 14 " with flat glass, $2.00.
" " " " with bent glass, $2.50.
" " 12 " with flat glass, $1.75.
" " " " with bent glass, $2.25.

Morocco Case Thermometer.—(Fig. 590.)—This thermometer is mounted on a stout metallic plate, and inclosed in a neat morocco case, with hinges and hooks to fasten the case, and ring to suspend it by, is suitable for travellers, may be easily taken out of the case and used for immersing in water, in taking the temperature of springs, &c. The most usual size is eight inches long, but they are also made six, four and a half, and three inches. Price, $1.50.

If with ivory scale, 50 cents extra.

Fig. 591.

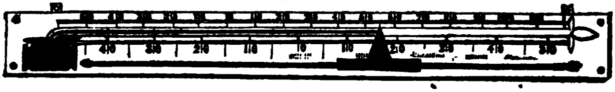


Self-Registering Thermometer for extreme Heat and Cold.—(Fig. 591, as above.)—In meteorological observations it is of great importance to ascertain the limits of the range of the thermometer in a given period of time, as during a day or night while the observer is absent. The self-registering thermometer most generally used for this purpose consists simply of two thermometers, one mercurial, and the other of alcohol, having their stems horizontal; the former has for its index a small steel wire, and the latter a minute thread of glass, having its two ends formed into small knobs.

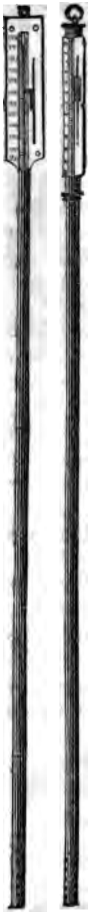
The wire lies in the vacant space of the mercurial thermometer, and is pushed forward by the mercury whenever the temperature rises, and pushes that fluid against it; but when the temperature falls, and the fluid retires, this index is left behind, and consequently shows the maximum. The other index of glass lies in the tube of the spirit thermometer immersed in the alcohol; and when the spirit retires, by depression of temperature, the index is carried along with it, in apparent contact with its interior surface; but on increase of temperature, the spirit goes forward and leaves the index, which, therefore, shows the minimum of temperature since it was set. As these indices merely lie in the tubes, their resistance to motion is altogether inconsiderable. The steel index is brought to the mercury by applying a magnet on the outside of the tube, and the other is duly placed at the end of the column of alcohol, by inclining the whole instrument.

Price, - - - - - - -	$4.00.
" with long cylindrical bulbs and magnet to move indexes, -	$4.50 and $5.00.
" mounted singly, mercurial or day thermometer, - - - -	$2.50.
" " " alcohol or night thermometer, - - - -	$2.00.

Fig. 592.



Figs. 593, 594.



Self-registering thermometer (Fig. 592) for extreme heat or cold, with index, extra large size, 12 inches long. Price, $3.00.

Thermometer for Sugar Boiling.—(Figs. 593 and 594.)—This consists of a thermometer usually 3 or 4 ft. long, the graduations being confined to a space of about twelve inches long at the upper end of the instrument, allowing the longer part and bulb to be immersed in the boiling sugar. The thermometer is graduated to 270 degrees or upwards, and is mounted in a frame of wood or brass, and having an index which may be set at any degree required for the heat to be maintained at. Price, best brass case instrument,
4 feet long, $7.00.
" " " " 3 " " $5.50.
" mahogany case instrument,
4 feet long, $6.00.
" " " " 3 " " $4.50.
" " " " without index, 3 feet long, $4.00.

Gothic Mantel Thermometers.—The author manufactures these in a great variety of styles and mounting, bronze, antique bronze, green bronze, gilt, embracing over twenty-five different patterns, most of which are very elegant; and the thermometers being manufactured under his immediate superintendence, can be relied on for accuracy. A few of the patterns are represented on the two following pages.

Fig. 595

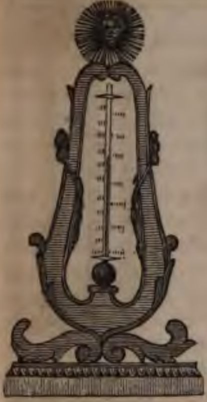


Fig. 596.

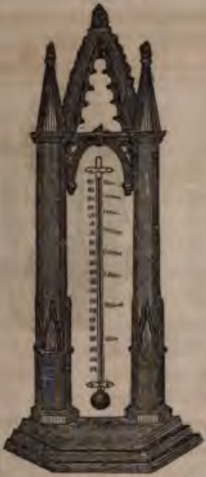
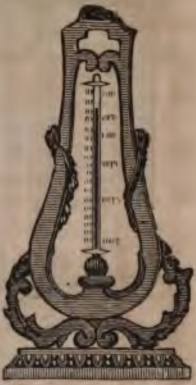


Fig. 597.



Price of Fig. 595, $1.75.
" " 596, $2.00.
" " 597, $1.75.

Fig. 598.

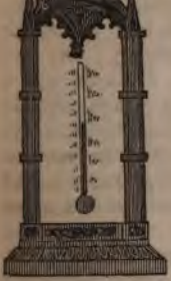


Fig. 599.

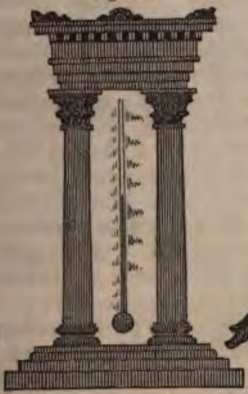
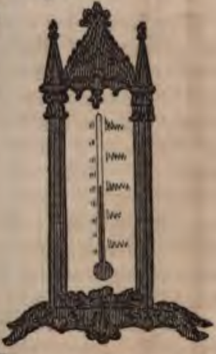


Fig. 600.



Price of Fig. 598, $1,37.
" " 599, $2.00.
" " 600, $1.50.

Fig. 601.

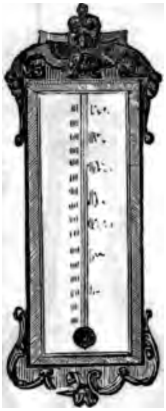


Fig. 602.

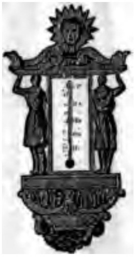
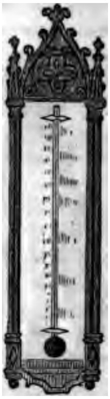


Fig. 603.

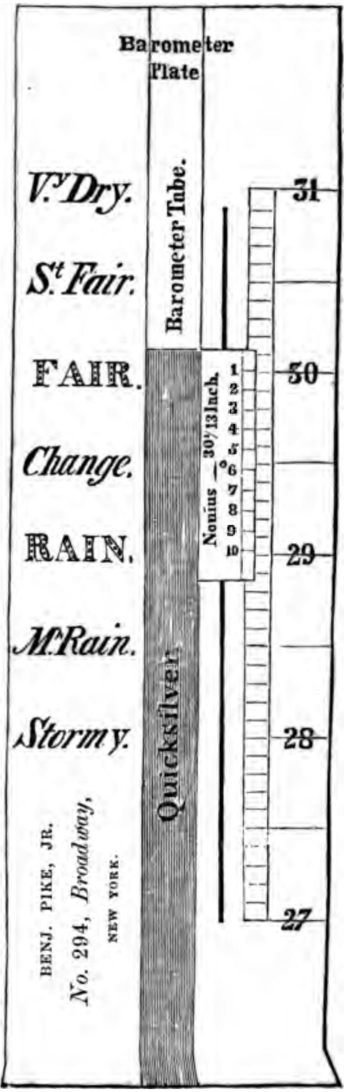


Price of Fig. 601, $1.50.
" " 602, $1.25.
" " 603, $1.75.

THE BAROMETER.

The barometer is an instrument for measuring the weight or pressure of the atmosphere, and sometimes called a weather glass. It consists of a cylindrical glass tube, whose diameter is about half of an inch, and its length thirty-four inches, filled with prepared mercury; one end of the tube is hermetically sealed, and to the open end a reservoir of hard wood is cemented, having a soft flexible leather bag for its bottom, the whole containing the mercury, but not quite full; the atmosphere pressing on the surface of the leather, and causing it to yield to the pressure of the external air, sustains the mercury in the tube to the same height as if exposed to the atmosphere.

The tube and reservoir are fixed to a frame of wood, and suspended in a vertical position, having a scale graduated from twenty-seven to thirty one-inches, which is the distance from the surface of the mercury in the reservoir; the inches are divided into tenths, and in the best instruments there is *a vernier moving* in a groove in the plate, and subdividing the tenths into hundredths of an inch; to the upper edge of the vernier is a small index which is to be placed in a line with the mercury; a small stud is attached to move the vernier up or down as occasion may require; the face of the scale and vernier are of brass, silvered, and in the best instruments they are covered with glass, also having rackwork to move the vernier up and down by means of a key in the front of the frame below the scale. Through the under part of the frame passes a screw, with a flat round plate at its end; by turning the screw, the bag may be so compressed as to force the mercury up to the top of the tube, and also to fill the reservoir, which keeps it steady, and prevents the tube from breaking, by the mercury dashing against the top, when carried about. The height of the mercury in the tube above the surface of the mercury in the basin is *called the*



BAROMETER SCALE.

standard altitude, and the difference between the greatest and least altitudes is called the limit or scale of variation.

The mercury in the barometer tube will subside, till the column be equivalent to the weight of the external air upon the surface of the mercury in the basin, and it is therefore a criterion to measure that weight, and chiefly directed to that purpose. In this country the standard altitude fluctuates between twenty-nine and thirty and a half inches.

Rules for observing the Barometer.—1. The rising of the mercury presages, in general, fair weather; and its falling, foul weather; as rain, snow, high winds, and storms. 2. In very hot weather, the falling of the mercury foretells thunder. 3. In winter, the rising presages frost; and in frosty weather, if the mercury fall three or four divisions, a thaw will certainly follow. But in a continued frost, if the mercury rise, it will certainly snow. 4. When foul weather happens soon after the falling of the mercury, expect but little of it; and, on the contrary, expect but little fair weather, when it proves fair shortly after the mercury has risen. 5. In foul weather, when the mercury rises much and high, and so continues for two or three days before foul weather is quite over, then expect a continuance of fair weather to follow. 6. In fair weather, when the mercury falls much and low, and thus continues for two or three days before the rain comes, then expect a great deal of wet, and probably high winds. 7. The unsettled motion of the mercury denotes uncertain and changeable weather. 8. You are not so strictly to observe the words engraved on the barometer plate, as the rising or falling of the mercury, for should it stand at much rain, and then rise to changeable, it presages or foretells fair weather, although its continuance is not to be depended on so much as if the mercury were higher. But when it stands at fair, and sinks to changeable, it indicates bad weather, though not so much in proportion as if it had sunk lower. Therefore, in order to pass a right judgment of the weather, the point where the mercury stands is not so much to be regarded, but it should be particularly considered whether the mercury is actually in a rising or falling state. For its minutest alterations should be accurately attended to for the purpose of forming a right judgment respecting the weather expected to succeed.

When we would observe the barometer with accuracy, the tube should be first shaken by gently tapping the front of the frame with the back part of the fingers, from three to five times.

Plain Barometer.—(Fig. 604.)—Barometers are mounted in a variety of styles; the figure represents one in a neat polished mahogany frame, having a thermometer on one side of the scale, and a screw at the bottom of the reservoir or cistern of the barometer for the purpose of forcing the mercury up, which, filling every part of the tube, renders the instrument portable, and may be carried in a horizontal or other position in transportation.

Price, $10.00.

Barometer with Glass Door.—(Fig. 605.)—This has a neat frame of mahogany or rosewood, with round or square top, and having a small door with glass in front of the scale, with thermometer and portable screw, as described in the preceding figure.

Price, - - $11.00.
" with vernier subdividing the graduations to 100 of an inch, $12.00.

Fig. 604.

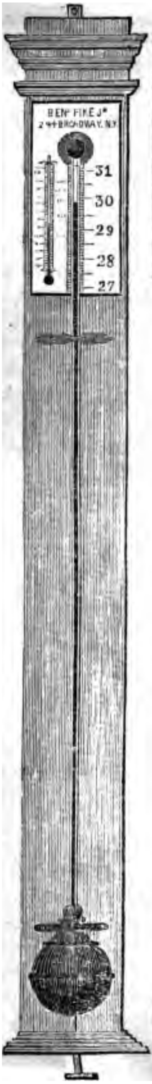


Fig. 605.

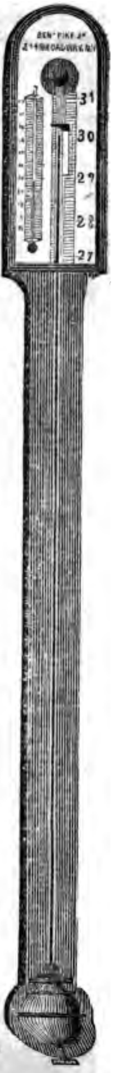


Fig. 606.

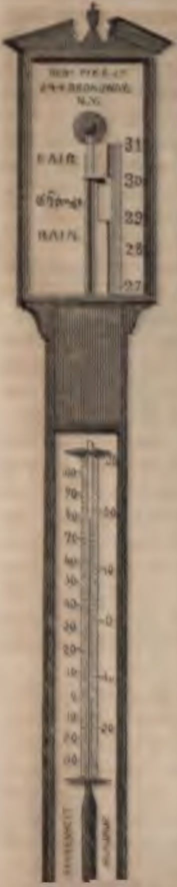
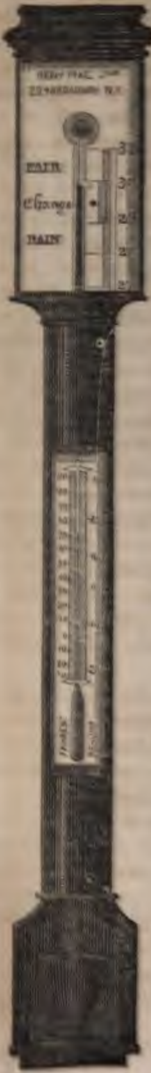


Fig. 607.



Best flat front Barometer.—(Fig. 606.)—The best flat front mahogany case barometer having vernier and glass door, with large thermometer in the body of the case, having a long cylindrical bulb to the tube, exposing thereby a large surface to the atmosphere, graduated to Fahrenheit and centigrade scales, and covered with glass, portable screw at the bottom, and the case highly polished. Price, $16.00.

Best Circular Front Rosewood Barometer.—(Fig. 607.)—The most elegant barometer is the circular front rosewood mounted instrument, with large thermometer in the body of the case, having Fahrenheit and Reaumur's, or centigrade scales, and the tube having a long cylindrical bulb, the scales covered with circular glasses; vernier to the scale having rack motion, which is moved by a key in the front of the case below the scales. The case of this instrument is highly finished and polished, and besides being an instrument of great utility is quite ornamental.

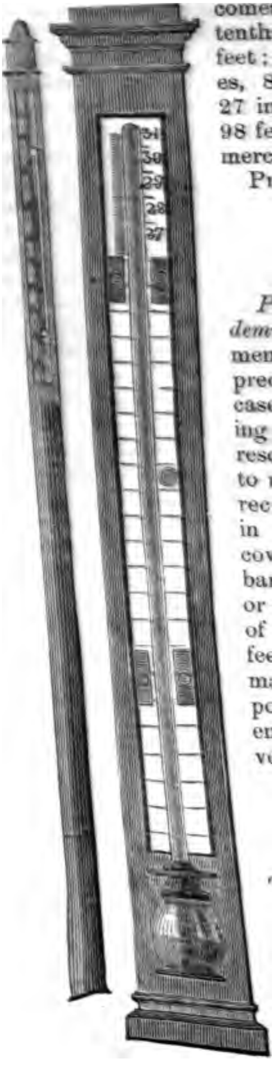
Price, $22,00 and $25.00.

The Mountain Barometer.—(Fig. 608, next page.)—A very important property of this valuable instrument is that of determining heights, and its accuracy is inferior to no other mode; on this account it is not only very useful to surveyors, but highly interesting to philosophers, scientific men, &c. It consists of a tube, &c., as described in the first article under this head, having a smaller reservoir for the mercury, which is inclosed in a round case, about one and a half inches in diameter, at the upper part of which an opening, of about one quarter of the circumference of the case, and twelve inches long, is made, the sides of which are inclined towards the tube, on one of which the barometer scale is attached, which ranges from twenty to thirty-one inches, divided to twentieths of an inch, and having a vernier sliding on the scale, subdividing these into five hundredths of an inch; to the upper edge of the vernier there is a small index to be set in a line with the mercury; on the other side of the opening there is a delicate thermometer, which may be detached if required; that part of the case to which the scales are attached is surrounded with a brass tube, having an aperture cut in it corresponding to the opening in the case; there is also a narrow opening at the back through the case and tube, for allowing the light to be seen through, and more accurately observing the surface of the mercury; the tube may be turned round so as to close these openings entirely, and is kept on by a brass cap at the top, into which a ring may be screwed for suspending the instrument.

As the reservoir in this instrument is small, and any considerable depression of the mercury would considerably alter the level therein, a correction is made in the best instruments, for which purpose the reservoir is accurately measured, and the contents of one inch, compared with one inch of the tube, ascertained, which is to be subtracted from the height when the mercury falls below thirty inches, which amount of correction is engraved on the brass cap. The reservoir is inclosed in a brass case, having a portable screw, over which the brass cap is screwed. This barometer has been used by many scientific gentlemen in their observations, and is the least liable to derangement of any used for measuring heights; is very light, and may be inverted, and with care used as a walking stick in ascending heights.

The density or weight of the atmosphere is not equal, but

Fig. 608. Fig. 609.



the higher we ascend the rarer it becomes. At 31 inches a fall of one-tenth of an inch indicates a height of 83 feet; at 30 inches, 85 feet; at 29 inches, 87 feet; at 28 inches, 91 feet; at 27 inches, 94 feet; and at 26 inches, 98 feet; for every tenth of an inch the mercury falls.

Price, - - -	$20.00.
" with corrections for level in reservoir, and extra finish,	$25.00.

Pike's Mountain Barometer for Academies.—(Fig. 608.)—This is an instrument similar in its construction to the preceding one, but of a larger make; the case being two inches in diameter, having a brass cover to the scales, and the reservoir of mercury being so large as to make it unnecessary to use any correction for the level, and is inclosed in a brass case with portable screw covered with a cap screwing on. The barometer scales extend to twenty-five or twenty-six inches, which will allow of the measurement of a height of 4000 feet or over. This is a stout and well made instrument, the brass work highly polished, and the demand for them has enabled the maker to sell them at very low rate.

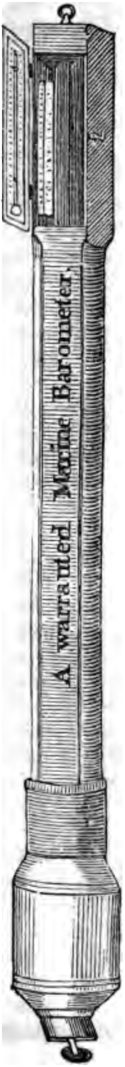
Price, - - -	$10.00.
" with vernier,	$12.00.

Standard Barometer.—(Fig. 609.)—This consists of a tube of unusually larg size filled with mercury, and inverted i a large glass reservoir also containin mercury, the top of which is exposed the atmosphere, and covered by wooden cap, through which a point steel rod passes, fastened to a projecti

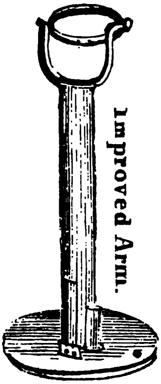
the lower part of the barometer scale,
ı reaches to the surface of the mercury.
ıcale is fastened to the case by four screws
ıg through long holes covered by springs,
ing the scale and point attached to be
d up or down, and set at any time in exact
ct with the surface of the mercury, by a
knob near the centre of the scale. From
ıd of the steel point the scale commences,
ȝ graduated to thirty-one inches, subdivid-
usual, and having a vernier with index;
ıounting consists of a neat mahogany case,
ɔolished. This is a valuable instrument
ȝ it can be set up by a maker, but cannot
ly be transported without being put out
ler, requiring to be kept in a vertical po-
, but may be sent unfilled, and requires
ttle skill to fill and immerse in the mercu-
rections for which will be furnished.

Price, $22.00.

Fig. 610.

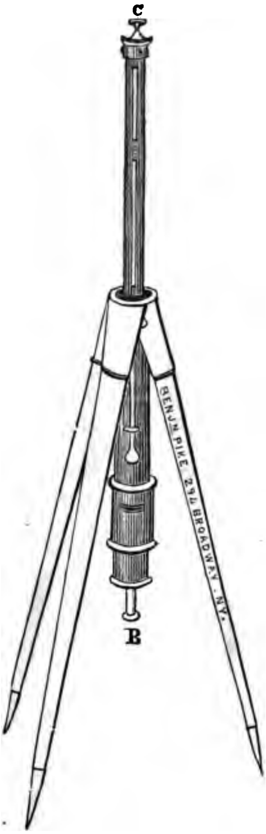

A warranted Marine Barometer.

ırine Barometer.—(Fig. 610.)—The ba-
er is of great use to the mariner, who is
ɔy enabled to foresee and prepare for sud-
hanges of weather. The marine barome-
nsists of a glass tube with reservoir of
ıry, as in the usual barometer, but having
tion of the lower part con-
d to a very fine bore, to
nt the unsteadiness of the
ıry, which would other-
ɔe occasioned by the roll-
the ship. The tube is
ed in a mahogany case,
ɘ in front, and rounded
ıe sides, and enlarged
vhat at the upper end for
ing the scales, for which
is an opening with the
fixed on the sides, which
raduated as in any other
ıeters; this opening is
ed by a small *door, on the*


Improved Arm.

inner side of which is fixed a thermometer. The reservoir is inclosed in a brass case, having a portable screw beneath. The barometer is suspended in a vertical position, by a brass arm and gimbals, attached by thumb-screws to the side of the case, just above the middle, which allows the barometer to hang always in a vertical position, however the ship may roll; attached to the arm there is a stout circular plate, having holes for screws, to fasten the instrument to any part of the cabin of the ship; the arm is jointed at the plate for the purpose of turning the arm and barometer up, that it may be out of the way when not required in use. Price, - - - $20.
" fine finished, $25.

Fig. 611.



Troughton's Mountain Barometer.—(Fig. 611.)—The employment of the barometer for the determination of heights, has caused it to become an interesting instrument to the philosopher and traveller; and many attempts have been made to improve it, and render it portable, that it may be conveyed from place to place, without much inconvenience or risk. The adjoining figure represents the portable barometer, as constructed by Mr. Troughton. In the brass box, A, which covers the cistern of mercury near the bottom of the tube, are two slits made horizontally, precisely similar and opposite each other, the plane of the upper edges of which represents the beginning of the scale of inches, or zero of the barometer. The screw, B, at the bottom, performs a double office; first, it is the means of adjusting the surface of the mercury in the glass cistern to zero, by just shutting out the ight from passing between it and the upper edges of the above-named slits; and secondly, by screwing it up, it forces the quicksilver upwards, and by filling every part of the tube, renders the instrument portable.

The divided scale on the upper part, is subdivided, by the help of a vernier, to the one thousandth of an inch. The screw, c, at the top, moves a sliding piece, on which the vernier scale is divided, the zero of which is at the lower end of the piece. In taking the height of the mercury, this sliding piece is brought down and set nearly by the hand, and the contact of the zero of the vernier with the top of the mercurial column is then perfected by the screw, c, which moves the vernier the small quantity that may be required, just to exclude the light from passing between the lower edges of the sliding piece, and the spherical surface of the mercury.

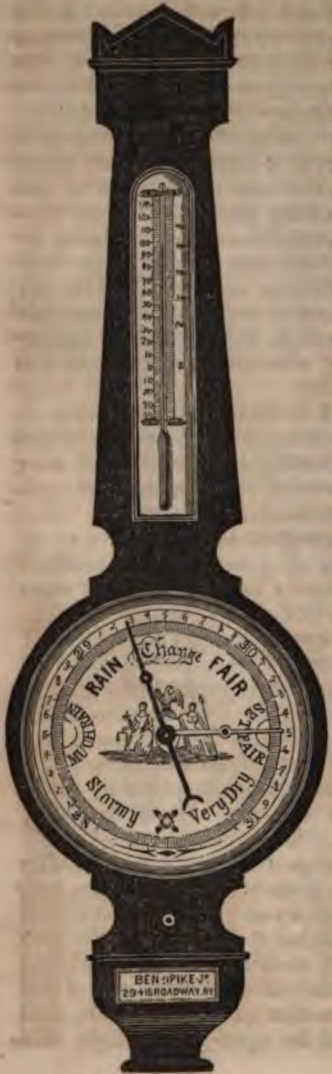
The barometer is attached to the stand by a ring, in which it turns ronnd with a smooth and steady motion, for the purpose of placing it in the best light for reading off, &c.; and the tripod stand, when closed, forms a safe and convenient packing case for the instrument.

A thermometer is always attached to the lower part of the barometer, to indicate its temperature, while another, detached from the instrument, is employed at the same time, to show the temperature of the surrounding air.

The barometrical method of determining differences of level, is founded upon the principle that the strata of air decrease in density, in a geometrical proportion, when the elevations above the surface of the earth increase in an arithmetical one. Therefore, from the known relation between the densities and the elevations, we can discover the elevations by observations made on the densities by means of the barometer. Price, $50.00.

The Wheel Barometer.—(Fig. 612, next page.)—The wheel barometer consists of a glass tube, closed at one end, and the other open, and bent upwards, and of thirty-two inches or upwards in length exclusive of the bend; the tube is entirely filled with prepared mercury, which, on placing in a vertical position, will subside in the closed end of the tube and rise in the open tube that is bent upwards, until the difference in the levels will be equal to the height of a

Fig. 612.



column of mercury which will balance the weight of atmosphere; so that any change in the pressure of the atmosphere, will have an equal effect on the mercury at the closed end and at the open end; and thus, through whatever space the mercury may rise in the closed end, it will be depressed to the same extent in the open end; the tubes at these parts being of precisely the same diameter, while between them the tube is contracted. Upon the surface of the mercury in the open end floats a glass weight, suspended by a silk thread over and around a brass pulley, to the other end of which is attached another weight, not quite as heavy, acting as a counterpoise to the former. The axis of the pulley passes through the frame and centre of the dial plate, and carries a blued steel hand, which revolves as the pulley turns round. The weight on the surface of the mercury being nearly supported by the counterpoise, rises or falls freely as the surface of the mercury on which it floats is elevated or depressed by the weight of the air. If the circumference of the wheel be one inch, then one entire revolution of the wheel will correspond to an ion of level amounting to one inch in each tube, or ches in the height of the barometric column; and as ıl plate may be from twenty to thirty-six inches in ıference, five to nine inches on the graduated plate ponds to one inch of the column, which is divided into ındred parts, each of which is distinctly perceptible.

frames are usually of mahogany, the best ones of ood, highly polished; the dial-plate is from six to inches in diameter, and elegantly engraved and d, and is covered by a brass ring containing a convex r glass; also a thermometer capable of being de-., having a separate frame sunk into the body of the of the instrument, and covered with a glass; the ometer tube having a long cylinder, instead of a round or containing the mercury, thus exposing a greater to be acted on by the atmosphere. In the back of ıme of the instrument is a cavity covered by a hinged within which the tube and fixtures are enclosed.

re is usually an index of polished brass, working on ial plate of the best instruments, movable by a key the dial, and serving to indicate the position of the when last observed. The mode of fitting up this in-ent gives it an elegant appearance as a piece iture.

rice of 8-inch, in mahogany frame,	$12.00.
" 10-inch, " "	$15.00.
" 8-inch, best rosewood,	$15.00.
" 10-inch, " "	$18.00.
" 12-inch, " "	$25.00.

Fig. 613.

gnosticator, or Storm Glass.—(Fig. 613.)— r curious instrument, formed of different com-ıns, which will indicate the weather; particu-high wind, storm, or tempest. It will be able by sea and land, being portable, and found to be very exact and useful.

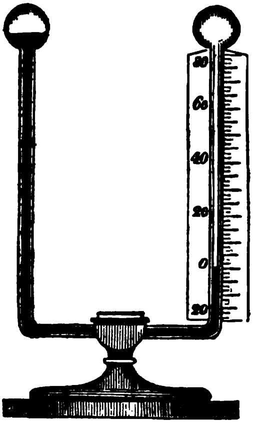
es to be observed.—1. If the weather is to be ıe substance of the composition will remain en-at the bottom, and the liquid will be very clear. Previous to changeable weather for rain, the ınce will rise gradually, and the liquid will ry clear, with the appearance of a small star tion.

3. Before a storm or extraordinary high wind, the substance will be partly at the top, and will appear in form of a large leaf; and the liquid will be very heavy, and in a fermentation. This will give twenty-four hours' notice before the weather changes.

4. In winter time, generally the substance will lie rather higher, particularly in snowy weather or white frost; the composition will be very white, with white spots in motion.

5. In summer time, the weather being very hot and fine, the substance will be quite low. Price, $1.25.

Fig. 614.



Differential Thermometer.—(Fig. 614.)—This instrument consists of a long glass tube, twice bent at right angles, having a bulb at each extremity. The tube contains a quantity of sulphuric acid, tinged with carmine. The instrument is furnished with a scale of 100 equal parts, and is fixed upon a wooden support. Both the bulbs of the instrument being exposed to the same temperature, it is not in the least affected; but as soon as one of the bulbs is exposed to a higher temperature than the other, the difference between them is delicately shown by the falling of the colored fluid below the bulb, which is most heated. This instrument not being affected by the variations of atmospherical pressure, nor by fluctuations of temperature in the atmosphere, it is admirably fitted for experiments on radiant heat. Price, $1.50.

Howard's Differential Thermometer.—(Fig. 615, next page.)—This instrument is a modification of the last, and considered by some as more convenient, the difference consisting in the balls being placed the one above the other.

Price, $1.50.

Fig. 615.

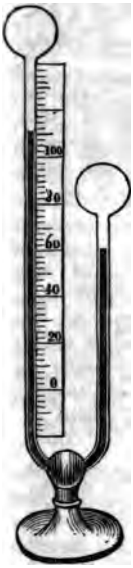
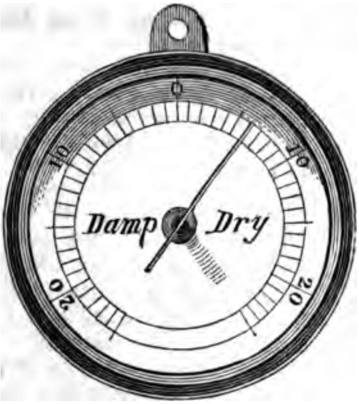


Fig. 616.



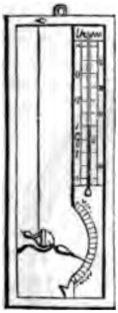
The Oat Beard Hygrometer.—(Fig. 616.)—This hygrometer is formed of the beard of the wild oat, one end of which is fixed in a small column, and usually placed in the centre of a round brass case, covered with a glass; the other end has a small index attached, usually made of a slender piece of light wood. Within the case there is a dial, divided into equal parts and numbered from 0 to 30 each way, and on one side the word *Dry*, and on the other *Damp*. In the sides of the case there is a number of holes, in order that the atmosphere may have free access to the interior of the instrument. There is a spring in the back of the case, attached to the column, by which the index may be set at 0 on the dial.

When this instrument is exposed to dryer or moister air, the small index, by turning round, either in one direction or the other, indicates the state of the atmosphere.

This is a simple and useful instrument for ascertaining the comparative dryness or dampness of different apartments, beds, &c., but it is not suited for meteorological observations.

Price, $2.50.

Fig. 617.



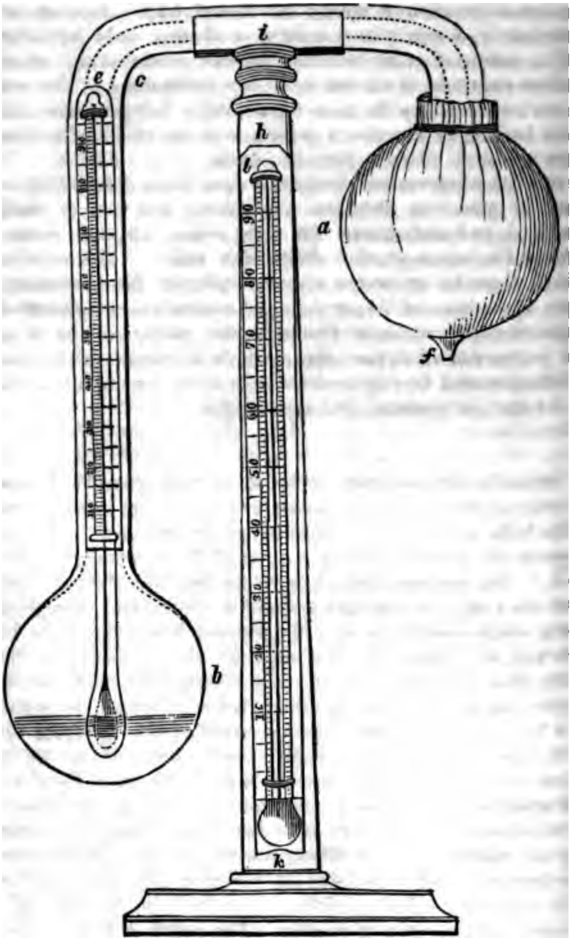
Saussure's Hygrometer (Fig. 617) consists of a human hair prepared by boiling it in caustic ley; one end of the hair is fixed to the upper part of a frame, usually about ten inches long, and four wide, and the other end passes round the axis of a small grooved wheel or pulley, the axis of which carries a counterpoise by which the hair is kept stretched, and an index which moves over a graduated arch; on the upper part of the scale there is usually fixed a thermometer. When the surrounding air becomes more humid, the hair absorbs an additional quantity of moisture, and is elongated; the counterpoise consequently descends and turns the pulley, whereby the index is moved towards the one hand or the other. On the contrary, when the air becomes dryer the hair loses a part of its humidity, and is shortened. The counterpoise is consequently drawn up, and the index moves in the opposite direction. Price, $5.50.

Hygrometers by Condensation.—The two preceding hygrometers are constructed on the principle of absorption, and for meteorological researches are of but little use. Those remaining to be described are constructed on the principle of condensation, and form valuable instruments for the meteorologist, of which Mason's is the simplest and most modern construction. In order to give an idea of the general principle on which they depend, let us conceive a glass jar, having its sides perfectly clean and transparent, to be filled with water, and placed on a table in a room where the temperature is, for example, 60°; the temperature of the water being the same as that of the room. Let us next suppose pieces of ice, or a freezing mixture, to be thrown into the water, whereby the water is gradually cooled down to 55, 50, 45, &c., degrees. As the process of cooling goes on, there is a certain instant at which the jar loses its transparency, or becomes dim; and on attentively examining the phenomenon, it is found to be caused by a very fine dew, or deposition of aqueous vapor on the external surface of the vessel. The precise temperature of the water, and consequently of the vessel, at the instant when this deposition begins to be formed, is called the dew point, and is capable of being noted with great precision. Now this temperature is evidently that to which, if the air were cooled down under the same pressure, it would be completely saturated with moisture, and ready to deposit dew on any body in the least degree colder than itself. The difference, therefore, between the temperature of the air, and the temperature of the water in the vessel when the dew begins to be formed, will afford an indication of the dryness of the air, or of its remoteness from the state of complete saturation.

But the observation which has now been described is capable of affording far more interesting and precise results than a mere indication of the comparative dryness or moisture of the atmosphere. With the help of tables of the elastic force of aqueous vapor at different temperatures, it gives the means of determining the absolute weight of the aqueous vapor diffused through any given volume of air, the proportion of vapor existing in that volume to the quantity that would be required to saturate it, and of measuring the force and amount of evaporation.

Daniell's Hygrometer.—(Fig. 618, next page.)—The cut represents Daniell's hygrometer, in which *a* and *b* are two thin glass balls of one and a quarter inch in diameter, connected together by a tube, having a bore of about one-eighth of an inch. The tube is bent at right angles over the two balls, and the arm, *b c*, contains a small thermometer, *d e*, whose bulb, which should be of a lengthened form, descends into the ball, *b*. This ball, having been about two-thirds filled with ether, is heated over a lamp till the fluid boils, and the vapor issues from the capillary tube, *f*, which terminates the ball, *a*. The vapor having expelled the air from both balls, the capillary tube, *f*, is closed hermetically by the flame of a lamp. This process is well known to those who are accustomed to blow glass, and may have been known to have succeeded, after the tube has become cool, by reversing the instrument and taking one of the balls in the hand, the heat of which will drive all the ether into the other ball, and cause it to boil rapidly. The ball, *a*, is now to be covered with a piece of muslin. The stand, *g h*, is of brass, and the transverse socket, *i*, is made to hold the glass tube, in the manner of a spring, allowing it to turn and be taken out with little difficulty. A small thermometer, *k l*, is inserted into the pillar of the stand.

Fig. 618.



The manner of using the instrument is this:—After having driven all the ether into the ball *b*, by the heat of th hand, it is to be placed in an open window, or out of door with the ball *b* so situated as that the surface of the liqui may be upon a level with the eye. A few drops of ether are then to be poured upon the covered ball. Evaporation immediately takes place, which, producing cold upon the ball *a*, causes a rapid and continuous condensation of the ethereal vapor in the interior of the instrument. The consequent evaporation from the included ether produces cold in the ball *b*, the degree of which is measured by the thermometer, *d e*. This action is almost instantaneous. The thermometer begins to fall in two seconds after the ether has been dropped. A depression of thirty degrees is easily produced, and sometimes the ether boils, and the thermometer falls below 0° of Fahrenheit's scale. The artificial cold thus produced causes a condensation of the atmospheric vapor upon the ball, *b*, which first makes its appearance in a thin ring of dew, coincident with the surface of the ether. The degree at which this takes place is to be carefully noted. A little practice may be necessary to seize the exact moment of the first deposition, but certainty is very soon acquired. It is advisable to have some dark object behind the instrument, such as a house, or a tree, as the cloud is not so soon perceived against an open horizon. The depression of temperature is first produced at the surface of the liquid where evaporation takes place, and the currents which immediately ensue to restore the equilibrium are very perceptible. The bulb of the thermometer, *d e*, is not quite immersed in the ether, that the line of greatest cold may pass through it. The greatest difference that Mr. Daniell has observed in the course of four months' daily experiments between the external thermometer, *k l*, and the internal one, *e d*, at the moment of precipitation in the natural state of the atmosphere, was twenty degrees. In very damp weather the ether should be slowly dropped upon the ball, otherwise the descent of the thermometer is so rapid as to render it impossible to be certain of the degree. In dry weather, on the contrary, the ball requires to be well wetted more than once, to produce the requisite degree of cold. It is almost superfluous to observe, that care should be taken not to permit the breath to affect the glass. With these precautions the observation is simple, easy, and certain.

By combining the rise and fall of the barometer with the effects of this instrument, we learn to modify their results, and by so doing can hardly be deceived in the weather for many hours in advance. The indications are to be corrected according to circumstances in the following manner:—In summer time, when the diurnal variations of temperature are great, regard is to be had to the time of day at which the experiment is made. In the morning, supposing the difference between the temperature of the air and the constituent temperature of the vapor to be small, it is to be recollected, that the accession of heat during the day is great, and that the difference will therefore probably increase. If the point of condensation should at the same time be lowered, it is in indication of very fine weather. If, on the contrary, the heat of both should increase with the day in nearly equal progression, rain will almost infallibly follow, as the heat of the air falls with the setting sun. In showery weather, the indications of this instrument vary rapidly three or four degrees; and a person making observations at short intervals of time, may easily predict the approach of a storm.

Price, $14.00.

MASON'S HYGROMETER.

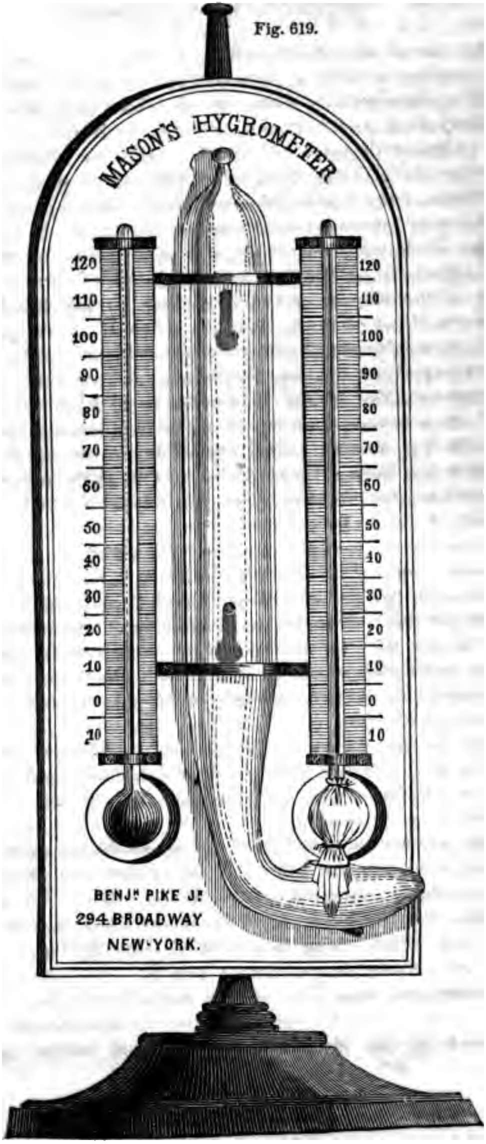
The use of this instrument (Fig. 619, next page) in the sick chamber will be at once evident, as a fire kept up in a closed room naturally dries the air which the patient has to breathe, and it soon becomes either more detrimental or beneficial in many diseases of the lungs, skin, or intestinal canal. It is the duty of the medical attendant to point out those conditions of the body which will be benefited or injured by atmospheric influences, and suggest the means by which this can be obviated as far as art will allow ; for in many cases life depends upon the temperature, state of dryness, or humidity of the climate or room in which an individual resides, which condition of the air it is the office of the instrument to constantly register, and show, by mere inspection.

If the apartment is too dry, which is frequently the case in frosty weather, it will be necessary to maintain sufficient evaporation from a tea urn, or other convenient apparatus, while the hygrometer points out when the proper degree of humidity has been attained ; the urn is then removed, and may be brought into the room again when required. On the contrary, if the air be required remarkably dry, it may be rendered so, either by raising the temperature of the room, or resorting to those substances which absorb vapors most rapidly.

Thus with the aid of this instrument (as it indicates both the temperature, dryness, and humidity of the air), an artificial locality may be produced by very simple and easy means ; and those, whose circumstances, avocations, or family ties, prevent them from seeking a climate suited to their peculiar constitution, can, to a very great extent, obviate the necessity by the assistance of the instrument now submitted to the public, the desideratum of which has been long felt, and its prospective uses fully appreciated by the reflecting portion of the profession.

If the air be very dry, the difference between the two thermometers will be great; if moist, less in proportion; and when fully saturated, both will be alike. For general purposes, it is only necessary to place the instrument in a retired part of the room away from the fire, and not exposed to the open doors or passages ; but for nice experiments, the observation should be always made in the open air and in the shade, taking especial care that the instrument be not influenced by the radiation of any heated bodies, nor any

Fig. 619.


MASON'S HYGROMETER
120
110
100
90
80
70
60
50
40
30
20
10
0
10
120
110
100
90
80
70
60
50
40
30
20
10
0
10
BENJ.N PIKE J.R
294 BROADWAY
NEW-YORK.

currents of air. Should the wind be strong upon the instrument, the "degrees of dryness observed," multiplied by two, gives the "absolute dryness" (the "excess of dryness" being omitted in the calculation), because a strong current of air makes the instrument indicate the excess of dryness, which is necessary to be added in a calm atmosphere.

If the absolute dryness of an apartment be required, the instrument must be placed in the shade and the dew-point found, which, subtracted from the temperature of the apartment, will give its absolute dryness. The reason is obvious, and arises from this law, namely, that air has its dryness doubled for every increase of temperature corresponding to 21° of Fahrenheit's thermometer, and in proportion for all intermediate temperatures.

It will detect the dampness of an apartment or bed.

The facility of registering meteorological observations by this instrument, will probably induce many to avail themselves of its use, and tend to enlarge that branch of science.

In regulating the hygrometrical state of the air in hot-houses, green-houses, &c., as well as in manufactories, warehouses, malting-houses, and in the laboratory of the chemist, its use will be duly appreciated.

The advantages it offers at sea cannot be too forcibly pointed out. The objections made by naval men to the barometer, leaving them in doubt whether to expect wind or rain by the fall of the mercury, would in a great measure be obviated by the joint observation of the hygrometer, because, if it indicate a relative degree of dryness, wind alone may be expected; if the contrary, then rain, or rain with wind, follows.

N. B.—The silk which covers the wet bulb, and thread which conveys the water to it, requires renewal about every month, and the fountain to be filled, when requisite, with distilled water, or water that has been boiled and allowed to cool, by immersing it in a basin of water till the aperture only is just upon the surface, and the water will flow in. If the hygrometer is placed out of doors in frosty weather, the fountain had better be removed, or the freezing of water within it may break it; in this case a thin coating of ice may soon be formed on the wet bulb, which will last a considerable time, and may be renewed when requisite.

Price, - - - - - - $3.50 to $5.00.

" best article in rosewood case, lined with velvet, $7.00.

TABLES FOR THE USE OF DR. MASON'S HYGROMETER.

TABLE OF DEGREES.

By the TABLE OF DEGREES is shown, *without calculation*, the Absolute Dryness of the Atmosphere, in degrees of Fahrenheit's Thermometer

Observe the NUMBER OF DEGREES THE TWO THERMOMETERS DIFFER, which are here called "Degrees of Dryness observed," and found IN THE FIRST COLUMN of the Table.

The *Second Column* merely contains the Figures which have been added to the Degrees of Dryness in the *First*, and multiplied by 2, to obtain THE ANSWER PUT DOWN IN THE THIRD COLUMN.

Mason's Hygrometer.	Degrees+excess×2=absolute dryness.		Leslie's Hygrometer compared with Mason's.
Degrees of dryness observed.	Excess of dryness to be added.	Absolute dryness existing.	
0	0.0	0.0	0
0.5	0.083	1.166	3
1	0.166	2.332	6
1.5	0.2495	3.499	9
2	0.333	4.666	12
2.5	0.4165	5.833	15
3	0.500	7.0	18
3.5	0.583	8.166	21
4	0.666	9.332	24
4.5	0.7495	10.499	27
5	0.833	11.666	30
5.5	0.9165	12.833	33
6	1.000	14.0	36
6.5	1.083	15.166	39
7	1.166	16.332	42
7.5	1.2495	17.499	45
8	1.333	18.666	48
8.5	1.4165	19.833	51
9	1.500	21.0	54
9.5	1.583	22.166	57
10	1.666	23.332	60
10.5	1.7495	24.499	63
11	1.833	25.666	66
11.5	1.9165	26.833	69
12	2.000	28.0	72
12.5	2.083	29.166	75
13	2.166	30.332	78
13.5	2.2495	31.499	81
14	2.333	32.666	84
14.5	2.4165	33.833	87
15	2.500	35.0	90
15.5	2.583	36.166	93
16	2.666	37.332	96
16.5	2.7495	38.499	99
17	2.833	39.666	102
17.5	2.9165	40.833	105
18	3.000	42.0	108
18.5	3.083	43.166	111
19	3.166	44.332	114
19.5	3.2495	45.499	117
20	3.333	46.666	120
20.5	3.4165	47.833	123
21	3.500	49.0	126
21.5	3.583	50.166	129
22	3.666	51.332	132
22.5	3.7495	52.499	135

EXAMPLE.—Temperature of the Air 57, wet bulb 54=3 degrees of dryness observed; then add 0.5 excess of dryness=3.5 and multiply by 2, which will give 7 degrees of absolute dryness existing.

To find the Dew Point—Subtract the Absolute Dryness from the Temperature of the Air. Example. 57—7=50 Dew Point.

To find the actual quantity of Vapor by weight in the Atmosphere.—Proceed as directed in the TABLE OF QUANTITY

The comparison of Mr. Mason's with the *Dew Point Hygrometer, and of Sir John Leslie's, will be seen in the same line of the 1st, 3d, and 4th columns of the Table.

Professor Daniell's Hygrometer is registered by the 3d column.

TO FIND THE QUANTITY OF VAPOR BY WEIGHT EXISTING IN THE ATMOSPHERE.

PROBLEM.—The temperature of the atmosphere in the shade, and of the *Dew Point*, being given, to find the quantity of vapor in a cubic foot of air.

If the temperature of the air and the *Dew Point* correspond, which is the case when both thermometers are alike, and the air consequently saturated with moisture, then in the *table of quantity* opposite to the temperature will be found the corresponding weight of a cubic foot of vapor expressed in grains.

EXAMPLE.—Let the temperature of the air be 70 deg. Fah., and the *Dew Point* the same—then opposite the temperature you have the weight of a cubic foot of vapor—8.392 grains.

But if the temperature of the air be different from the *Dew Point*, a correction is necessary to find the exact weight

EXAMPLE.—Suppose the *Dew Point* be 70 deg. Fah. as before, but the temperature of the air in the shade be 80 deg., then the vapor has suffered an expansion due to an excess of 10 deg., which requires a correction.

We find in the *table of corrections* for 10 deg. 1.0208.

Then divide 8.392 grains at the *Dew Point*, viz. 70 deg. by the correction corresponding to the degrees of absolute dryness, viz. 10 deg., and you have the actual weight of vapor existing.

EXAMPLE.—$\frac{8.3920}{1.0208}$ — 8.221 grains existing, which subtracted from weight of vapor, corresponding to the temperature of 80° Fah., gives the number of grains required for saturation at that temperature.

EXAMPLE.—11.333 grains at the temperature of 80 deg. Fah.
8.221 grains contained in the air.
3.112 grains required for saturation.

To find the relations of these conditions on the natural scale of humidity (complete saturation being 1.000), divide the weight of vapor at the *Dew Point* by the weight at the temperature of the air, the quotient gives the parts of 1.000 the degrees of saturation.

EXAMPLE.—$\frac{\text{8.392 grains at the Dew Point—70}}{\text{11.333 grains at the temp. of the air 80}}$ =.740 deg. of humidity saturation being 1.000

The principles of these calculations will be found in Professor Daniell's Meteorological Essays—Mr. Anderson's Essays on Hygrometry, in the Edinburgh Encyclopedia, vol. XI., and in the Edinburgh Journal of Science, vol. VII., page 43, in an excellent article on the Dew Point Hygrometer, by Mr. Foggo—from which the table of corrections has been partly subtracted. The Table of Quantity by Weight has been taken from Professor Daniell's Work on Meteorology; to which the reader is referred for further particulars.

TABLE OF QUANTITY,

Showing the Weight, in Grains, of a Cubic Foot of Vapor, at different Temperatures, from 0 to 95 Fahrenheit.

Temp.	Weight in Grains.	Temp.	Weight in Grains.	Temp.	Weight in Grains.	Temp.	Weight in Grains.
0	0.856	24	1.961	48	4.279	72	8.924
1	0.892	25	2.028	49	4.407	73	9.199
2	0.928	26	2.096	50	4.535	74	9.484
3	0.963	27	2.163	51	4.684	75	9.780
4	0.999	28	2.229	52	4.832	76	10.107
5	1.034	29	2.295	53	5.003	77	10.387
6	1.069	30	2.361	54	5.173	78	10.699
7	1.104	31	2.451	55	5.342	79	11.016
8	1.139	32	2.539	56	5.511	80	11.333
9	1.173	33	2.630	57	5.679	81	11.665
10	1.208	34	2.717	58	5.868	82	12.005
11	1.254	35	2.805	59	6.046	83	12.354
12	1.308	36	2.892	60	6.222	84	12.713
13	1.359	37	2.979	61	6.399	85	13.081
14	1.405	38	3.066	62	6.575	86	13.458
15	1.451	39	3.153	63	6.794	87	13.877
16	1.497	40	3.239	64	7.013	88	14.289
17	1.541	41	3.371	65	7.230	89	14.613
18	1.586	42	3.502	66	7.447	90	15.005
19	1.631	43	3.633	67	7.662	91	15.432
20	1.688	44	3.763	68	7.899	92	15.786
21	1.757	45	3.893	69	8.135	93	16.186
22	1.825	46	4.022	70	8.392	94	16.593
23	1.893	47	4.151	71	8.658	95	17,009

TABLE OF CORRECTIONS,

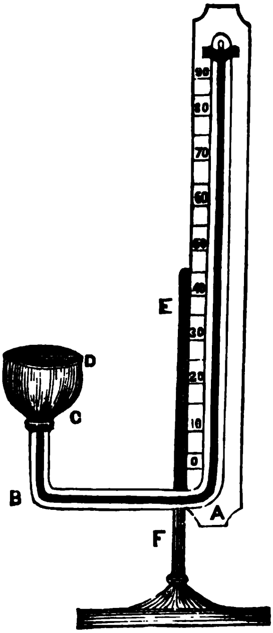
To be used when the Term of Deposition, or *Dew Point*, differs from the Temperature of the Air in the Shade.

Diff. of Temp.	Correction. —:—	Diff of Temp.	Correction. —:—	Diff. of Temp.	Correction. —:—	Diff. of Temp.	Correction. —:—
0	0.0000	13	1.0271	26	1.0542	39	1.0813
1	1.0020	14	1.0291	27	1.0562	40	1.0834
2	1.0041	15	1.0312	28	1.0583	41	1.0854
3	1.0062	16	1.0333	29	1.0604	42	1.0875
4	1.0083	17	1.0354	30	1.0625	43	1.0896
5	1.0104	18	1.0375	31	1.0646	44	1.0917
6	1.0125	19	1.0396	32	1.0667	45	1.0937
7	1.0146	20	1.0417	33	1.0687	46	1.0958
8	1.0167	21	1.0437	34	1.0708	47	1.0979
9	1.0187	22	1.0458	35	1.0729	48	1.1000
10	1.0208	23	1.0479	36	1.0750	49	1.1021
11	1.0229	24	1.0500	37	1.0771	50	1.1042
12	1.0250	25	1.0521	38	1.0792	51	1.1062
						52	1.1083

Rule. To find the weight of moisture in a cubic foot of air at any time. Divide the *weight in Grains*, found opposite the *Temperature*, corresponding to the Dew Point at the time, in the *Table of Quantity*, by the *Correction* found opposite to *Difference of Temperature* in Table of Corrections, corresponding to the absolute *dryness* existing at the time.

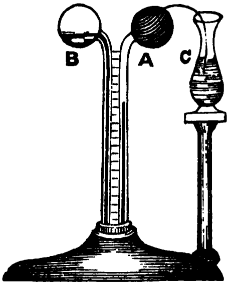
Jones's Hygrometer.—(Fig. 620.)—This instrument is the same in principle as Daniell's hygrometer, but simpler in its construction, more compact, and less expensive. The mercurial thermometer, with its tube at A B, is bent so as to bring its cylindrical ball, C, parallel with, and a little distance from its stem. The bulb is one inch long, and is terminated by a flattened surface, D, of black glass, which projects a little beyond the sides of the bulb. The bulb below the flattened surface is covered with black silk. The instrument is supported on the wire, E F, which is attached to the scale by a pivot, that allows the black surface to be inclined to the light. When used, the temperature of the air is first noted; then ether is poured on the silk cover of the bulb; and the condensation of the dew is seen on the black extremity of the bulb. Price, $5.00.

Fig. 620.



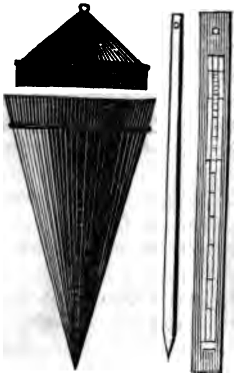
Leslie's Thermometric Hygrometer.—(Fig. 621.)—A thermometric hygrometer is an instrument formed from a differential thermometer, by covering one of its balls with tissue paper or black silk. Being kept moist with water, the evaporation produces cold, and that in a degree exactly accordant with the state of dryness in the atmosphere. A B, is the differential thermometer; the ball, B, being naked, that at A, covered; C, is a vessel of water, which has a few filaments of cotton that reach from the liquor in

Fig. 621.



it to the covered ball. This acts as a syphon, and keeps the ball moist. The graduated scale shows the degree of evaporation. When this hygrometer stands at 15°, the air feels damp, from 30 to 40° we reckon it dry, from 50 to 60° very dry, and from 60° upwards we should call it intensely dry. Price, $5.00.

Fig. 622.



Conical Rain Gauge.—(Fig. 622.)—The rain gauge is a simple cone of copper, of a given shape and capacity, which is placed in any situation where it will receive its due proportion of rain. It is usually placed in a piece of wood, bevelled out to fit the cone, and fastened to a post about eight feet high; the cap is placed in the cone with its base downward. However closely it may fit, by being pressed into it, there will still be sufficient room left between it and the sides of the gauge to permit the water to pass to its bottom. Immediately after every shower, or fall of rain, the water must be measured, and the contents registered and then discharged. On this will depend the accuracy of the account; for, from the construction of the gauge, the degrees of the scale near its bottom being the largest, small quantities may be measured with greater accuracy by this than by the gauges commonly used. The cap is intended to prevent evaporation before the measurement is made, should that be accidentally delayed. The measurement is made by putting down to the bottom of the gauge, the point of the measuring stick, and applying the distance between it and the water-mark to the scale.

The graduation of the scale is by hundredths of an inch for the first three-tenths of an inch, and above that by tenths and half-tenths. The intermediate distances may be measured by the eye, and set down in decimals. When showers or rains of short duration fall, it will be well to note the A. M. and P. M., with the hours between the beginning and end prefixed, in order that the time may be compared with that of observations made at other places. If the rain continues for any length of time, the observations should be made at suitable intervals before the water rises in the gauge.

It is important that the measure be taken without delay after every fall of rain, as experience has proved that the water in the gauge will soon become diminished by the rising along the inside of the gauge by capillary attraction, and then become dissipated by evaporation.

The usual precaution must be observed in giving the rain gauge such a position as that nothing may obstruct the rain in its most oblique direction from entering it, and no sediment must be suffered to remain in it.

The rain gauge must be kept remote from all elevated structures, to a distance at least equal to their height, and still farther off where it can be conveniently done, and be not more than ten feet above the surface of the ground.

In freezing weather, when the rain gauge cannot be used out of doors, it may be taken into a room, and instead of it a tin vessel should be procured for receiving the snow or sleet that may fall; this vessel must have its opening exactly equal to that of the rain gauge, and widen down to a sufficient depth, with a considerable slope. It should be placed where nothing can obstruct the descending snow from entering it, and where no drift snow may be blown into it. During a continued snow storm the snow may be occasionally pressed down into it. The contents of the vessel must at proper times be melted over a fire, and the water produced poured into the gauge to ascertain its contents, which must be entered in the gauge column of the register. Price, $2.50.

Cylindrical Rain Gauge.—(Fig. 623, next page.)—This instrument is a cylindrical vessel, about four feet high, and three and a twelfth inches in diameter, mounted on a base resembling the segment of a cone; the lower diameter of which is thirteen inches, the upper three and a twelfth inches, and the height eight inches. The base may be filled with sand, or other heavy material, to make the instrument steady; and the general form being that of an upright pedestal, it is a neat ornament for the garden or pleasure grounds. At the top of the cylinder is an open basin, corresponding with the base, having an aperture one-twelfth of an inch in diameter. The depth of the rain is indicated by a graduated glass tube, communicating with the bottom of

Fig. 623.

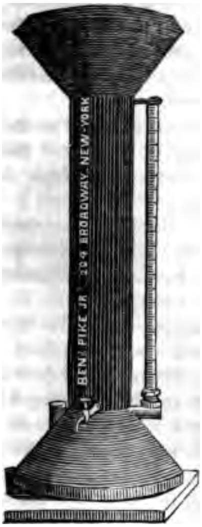
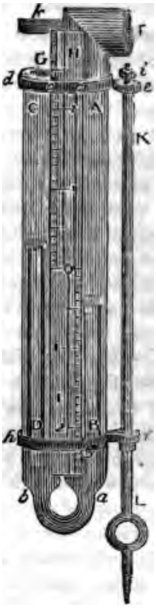


Fig. 624.



the cylinder. The water stands at the same height in the cylinder and glass tube, and being visible in the latter, the height is read immediately on the scale; and the cylinder and tube being constructed so that the sum of the areas of their sections is a given part, for instance a tenth, of the area of the funnel at its orifice, each inch of water in the tube is equivalent to the tenth of an inch of water entering the mouth of the funnel. A stop-cock is added, by which the water is drawn off when the observation is made. It is usually made of tin, and well japanned. Price, $7.50.

The same, with float within the cylinder and scale in the form of a rod, indicating the quantity by the rise of the rod and float. Price, $6.00.

Lind's Wind Gauge.—(Fig. 624, as above.)—An instrument serving to determine the velocity and force of the wind. An apparatus which is simple and easy of construction, and which seems to be well adapted for measuring the force of the wind with a sufficient degree of accuracy, consists of two glass tubes, A B, C D, five or six inches in length, and about four-tenths of an inch in bore; which are connected together like a siphon, by a small bent glass tube, *a b*, the bore of which is one-tenth of an inch in diameter. On the upper end of the leg, A B, there is a tube of latten brass, which is kneed or bent perpendicularly outwards, and has its mouth open towards F; on the other leg, C D, is a cover, with a round hole, G, in the upper part of it, two-tenths of an inch in diameter. This cover and the kneed tube are connected together by a slip of brass, *c d*, which strengthens the whole instrument, and serves to hold the scale, H I. The kneed tube and cover are fixed on with hard cement, or sealing-wax. To the same tube is soldered a piece of brass, *e*, with a round hole in it to receive the steel spindle, K L, and at *f* another such piece of brass is soldered to the brass hoop, *g h*, which surrounds both legs of the instrument. There is a small shoulder on the spindle at *f*, upon which the instrument rests, and a small nut, *i*, to prevent it from being blown off the spindle by the wind. The whole instrument is easily turned round upon the spindle by the wind, so as always to present the mouth of the kneed tube towards it. At the end of the spindle there is a screw, by which it may be screwed to the top of a post or stand; it has also a hole at L, to admit of a small lever for screwing it into wood with greater facility. A thin plate of brass, *k*, is soldered on the kneed tube, about half an inch above the round hole G, so as to prevent rain from falling into it.

This instrument serves to ascertain the force of the wind, by filling the tube half full of water, and pushing the scale a little up or down, till 0 upon the scale, when the instrument is held perpendicularly, be on a line with the surface of the water, in both legs of the wind-gauge. The instrument being thus adjusted, hold it up perpendicularly, and turning the mouth of the kneed tube towards the wind, observe how much the water is depressed by it in one leg, and how much it is raised in the other. The sum of the two is the height of a column of water, which the wind is capable of sustaining at that time; and every body that is opposed to that wind, will be pressed upon by a force equal to the weight of a column of water, having its base equal to the surface that is opposed, and its height equal to the altitude of the column of water sustained by the wind in the wind-gauge. Hence the force of the wind upon any body, where the surface opposed to it is known, may be easily found; and ready comparison may be made betwixt the strength of one gale of wind and that of another, by knowing the heights of the columns of water which the different winds were capable of sustaining. The heights of the column in each leg will be equal, provided that the legs are of equal bores; but unequal if their bores are unequal. For suppose the legs equal, and the column of water sustained by the wind to be three inches, the water in the leg which the wind blows into will be depressed one and a half inch below 0, and raised as much in the other leg. But if the bore of the leg which the wind blows into be double that of the other, the water will be depressed only one inch, whilst it is raised twice as much, or two inches, in the other, and *vice versa*.

For obtaining in this case the true height, Dr. Lind has subjoined the requisite formulæ. The use of the small tube of communication, *a b* is, to check the undulation of the water, so that the height of it may be read off from the scale with ease and certainty; and also to prevent the water from being thrown up to a much greater or less altitude than the true height of the column which the wind is able at that time to sustain. The author has calculated a table, by means of which, having the height of the column of water sustained in the wind-gauge, the force of the wind upon a foot square may be determined.

Height of Water in the Gauge.	Force of the Wind on one foot square in pounds Avoirdupois	Common designations of such Winds.
Inches.		
6	31.750	Hurricane.
5	26.041	Very great storm.
4	20.833	Great storm.
3	15.625	Storm.
2	10.416	Very high wind.
1	5.208	High wind.
0.5	2.604	Brisk gale.
0.1	0.521	Fresh breeze.
0.05	0.260	Pleasant wind.
0.025	0.030	A gentle wind.

When the height of the water is not exactly mentioned in the table, then that height may be separated into such parts as are mentioned in the table, and the sum of the forces answering to such parts will be the force of the wind correspondent to the height in question: thus, if the height of the water be 4.6 inches, then this height is equal to 4+0.5+0.1, which parts are all on the table; therefore,

Inches.		Pounds.
4	-	20.833
0.5	-	2.604
0.1	-	0.521

The sum is 23.958, which expresses the force of the wind when the height of the water in the gauge is 4.6 inches.

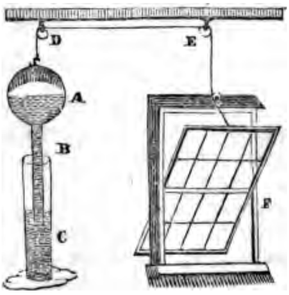
Any alteration that can usually take place in the temperature of the water, makes no sensible difference in this instrument.

In frosty weather this gauge cannot be used with common water. At that time some other liquor must be used, which is not subject to freeze; and, upon the whole, a saturated solution of common salt in water is the most eligible; but in that case (since the specific gravity of a saturated solution of salt is to that of pure water, as 1.244 to 1) the forces which are stated in the preceding table must be multiplied by 1.244. Thus, if in the preceding example the saturated solution of salt had been used instead of water only, the force of the wind on a square foot would have been 29.8 lbs.

When salt-water is used, the force of the wind, which is stated in the table, must be increased in the proportion of the specific gravity of salt-water to that of common water; thus, using the preceding example, we must say, as 1: 1.244 :: 23.958 to a fourth proportional, which must be found by multiplying the second term by the third, and then dividing the product by the first term; but, the first term being unity, we need only multiply 23.958 by 1,244.

Price, $6.00 to $8.00.

Fig. 625



Dr. Cumming's Statical Thermometer.—(Fig. 625.)—An instrument intended as a mode of opening windows and ventilators in apartments, by the variations in temperature of the included air.

A is a tube and ball, either of glass or iron, the ball being capable of holding four or five pints of air, and the tube, B, about twenty-five inches long. *A portion of the tube is filled* with mercury, and in this state is inverted, and the end plunged in a jar of the same fluid; to the top of the ball is attached a string, which, after passing over the pulleys, D and E, is finally fastened to the window, F. When the heat of the apartment rarifies the air in the ball, the mercury is driven out, and the ball and tube being thereby lightened, rise and suffer the window to swing itself open. An increase of cold will produce the contrary effect.

Price, $25.00.

OPTICAL INSTRUMENTS.

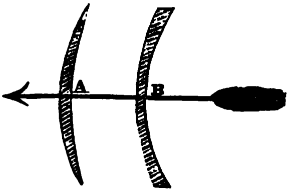
SPECTACLES.

When two lenses are mounted in a frame to fix before the eyes, they are denominated spectacles; the lenses are employed to render the objects before the wearer more distinct. The eye, which consists of a convex lens, called the *crystalline lens,* refracts the light proceeding from the object placed before it in the same manner as a convex glass; the image of the object is formed at the focus of the lens, where it is received on a screen at the back of the eye; this screen, called the *retina,* is an expansion of the optic nerve, which conveys the sensation of vision to the mind. As the crystalline lens of the eye will only produce distinct vision when the focus is thrown on the retina, it is obvious that should any defect occur with respect to that organ, indistinct and imperfect vision will arise. Thus, if the lens of the eye is not of a proper convexity to bring the image on the screen, an indistinctness must ensue. This is the case when the lens, through age, has become flattened; the image will then be thrown beyond the retina, and thus convey an imperfect representation of the object to the mind. To obviate this defect, we must make the rays pass through a glass of sufficient convexity to assist the eye, and enable it to form the image at the required place, which is in this instance done by shortening the focal distance of the crystalline lens of the eye. If, on the contrary, the eye should be too convex, or short-sighted, as is often the case with young persons, then the image will not be formed at a sufficient distance from the lens of the eye to reach the retina, and thus imperfect vision of distant objects is produced. To remedy *this defect concave* lenses must be resorted to, in order to diverge the rays before they enter the eye, and thus lengthen the focus of the crystalline lens to form an image on the retina. When the eyes are not directed near the centre of the spectacle-glasses, the obliquity of their surface to the rays will be increased, so as to occasion a confused appearance of the object. A great portion of this confusion is removed in the spectacles now usually made, when compared with those formerly employed, whose size, being very large, augmented the imperfection; for it may be observed that when objects are seen through spectacle-glasses, no more of the glass is employed at one view than a portion equal to the size of the pupil of the eye; this on an average may be reckoned at the eighth of an inch in diameter. Thus, we see how small a portion is used for the purposes of vision; but as it would be tedious to require the eye always to look through a small aperture, the glasses are left of a sufficient size to admit of a moderate degree of motion; and as we require a greater latitude horizontally than vertically, their figure is made of an oval, oblong, or octagon form.

The mountings are usually of gold, silver, and fine steel; these last rapidly superseding the others owing to their extreme lightness and elasticity, though many are sold which are mere imitations of the genuine article, having little or no elasticity; the bows are formed to slide, to turn, and with single branches, which last are convenient for ladies—not disturbing the hair; and for gentlemen requiring expedition in placing them on. Tortoise-shell mounted spectacles are also worn for extreme lightness, and by those objecting to metal frames; are pleasant to wear, but liable to be easily broken.

In the selection of spectacle-glasses great care should be used in examining them, and the first point of importance is the goodness of the material of which they are formed; this should be free from all veins or small bubbles, for if one of these occur in the portion through which we look, it will greatly impair the eyes. The next circumstance is that the figure of their surfaces should be perfectly spherical, for if they are curved more in one direction than in another they will injure the sight. The polish should be clean, and free from flare, which too often arises from the manner in which they are usually polished on heterogeneous surfaces, producing what is technically termed a curdled glass.

Fig. 626.



Periscopic Glasses.—(Fig. 626.)—Dr. Wollaston, in order to allow the eyes a considerable latitude without fatigue, invented a peculiar form of glasses, called by him periscopic, from two Greek words signifying seeing about; their form is that of a meniscus with the concave side always turned towards the eye. When they are intended for long-sighted persons, or old age, the anterior surface, or that next the object, is formed spherically convex, with a curve deeper than the concave, so as both to gain the required power, and compensate for the divergency occasioned by the concave side; this form is shown at A, in the above cut. The periscopic form employed for correcting the defect of a short or near-sight is shown in section at B, having its anterior surface convex, as in the former case; but here the concavity on its posterior side is increased to procure the required divergency, and compensate for the convex side.

Pebbles are made from blocks of rock crystal, usually brought from the Brazils; are cut into slices by the lapidary and ground to convex, concave, or periscopic forms by the optician for spectacles. They have the advantage of being more transparent than glass, much harder, do not scratch, take a higher polish, and consequently transmit more light; also are cooler to the eyes. The price of the best convex pebbles is usually $2.25, and for concave $3.25, or where they are purchased with the frames $1.75 extra, for convex, and $2.50 for concave.

Spectacles.—Oblong-eye Turnpin Bows.—(Fig. 627.)

Oval-eye Turnpin Bows.—(Fig. 628.)

Oblong-eye Single Temples for Ladies.—(Fig. 629.)

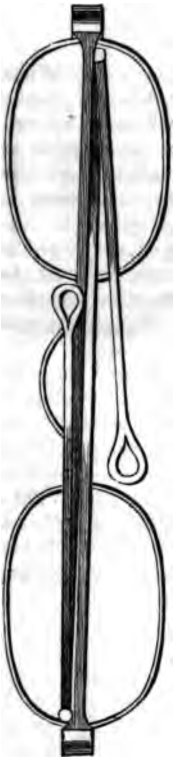


Fig. 627.

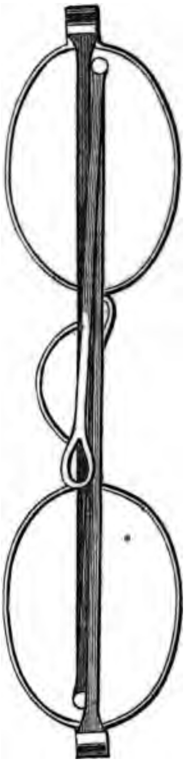


Fig. 628.

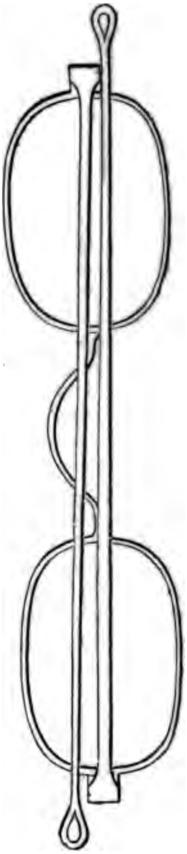


Fig. 629.

Price, in silver, - - $2.00 and $ 2.25.
" in gold, $7.00, $8.00, $9.00, and $10.00.

Spectacles.—Octagon-eye Sliding Bows.—(Fig. 630.)

Octagon-eye Turnpin Bows.—(Fig. 631.)

Octagon-eye Single Bows, for Ladies.—(Fig. 632.)

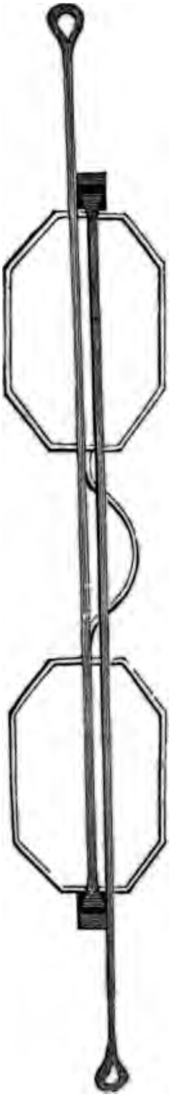


Fig. 632.

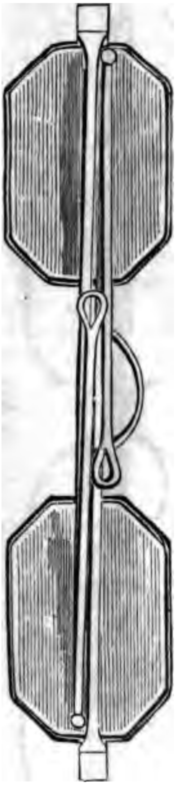


Fig. 631.

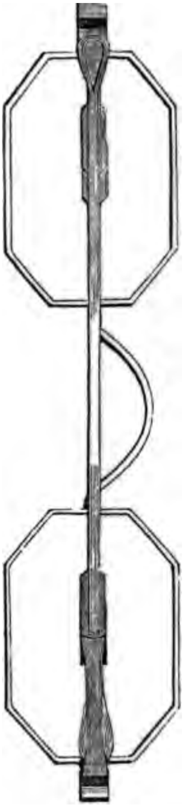


Fig. 630.

Price, silver, $2.00 and $2.25.
" gold, $8.00, $10.00,
and $14.00.

Spectacles.—Fine Elastic Steel Frames, Octagon Eye Turnpin Bows.—(Fig. 633.) Price, $2.50 ; extra fine, $3.
" ordinary, $1 to $1.50.

Fine Elastic Steel Frames, Oblong Eye, with Turnpin Bows.—(Fig. 634.) Price, $2.50 ; extra fine, $3 ;
" ordinary, $1 to $1.50.

Fine Elastic Steel Frames, Oblong Eye, with Single Bows, for Ladies.—(Fig. 635.)
Price, $2 ; extra fine, $2.50.
" ordinary, $1 to $1.50.

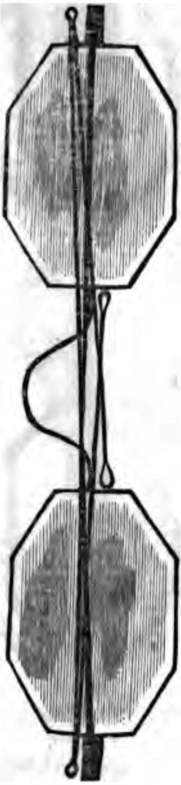


Fig. 633.

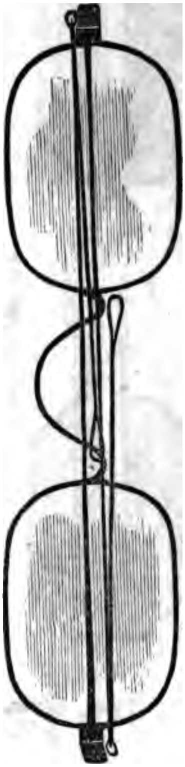


Fig. 634.

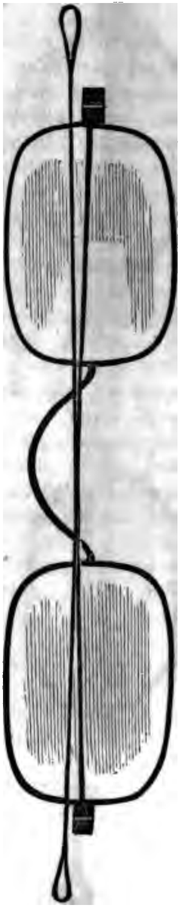


Fig. 635.

Oval Eye Tortoise-Shell Spectacles, with Single Bows.—(Fig. 636.)—Tortoise-shell mounted spectacles are worn for extreme lightness, and are pleasant to wear, but liable to be easily broken; they are sometimes mounted with silver, or gold bows, having single or double branches.

Price, single side, $2.00; turnpin side, $3.00.
" with silver bows, $3.00 and $3.50.

Spectacles for Reading and Public Speaking.—(Fig. 637.)—Spectacles adapted for reading and public speaking, having the top of the rim holding the glass flat, and being worn before the eyes in such a manner as to see through the glass in reading, and over the frame in speaking, and are particularly useful to clergymen and other public speakers, requiring the use of spectacles; they are mounted in silver, fine steel, and gold.

Price, in
" silver, $2.80.
" in fine steel, $2.50. and $3.00.
" ordinary, $1.50.
" gold, $10.00.

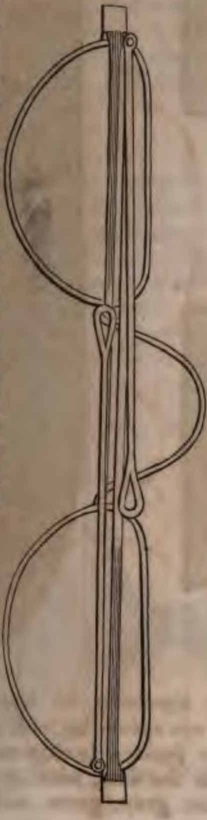


Fig. 637.

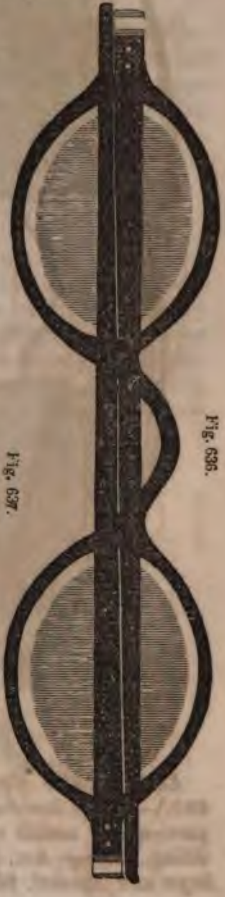


Fig. 636.

Fig. 638.

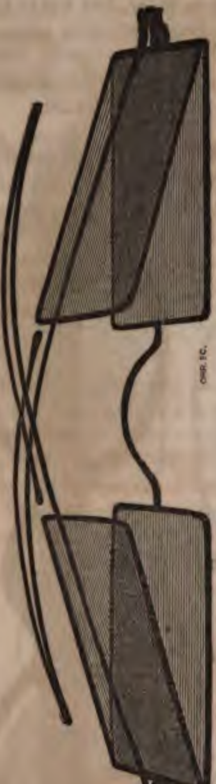
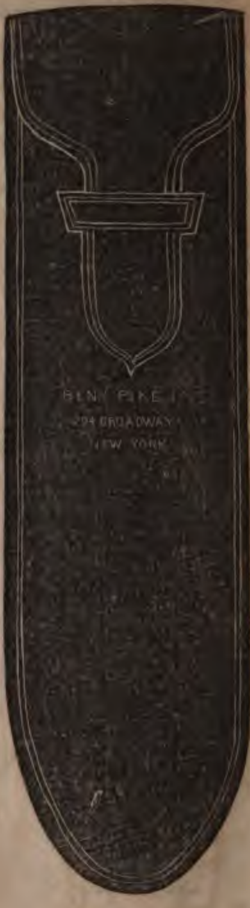


Fig. 639.



Large Double Eye Spectacles, or Eye Protectors.—(Fig. 638.)—Large double eye spectacles with shaded glasses, are particularly useful to persons having weak eyes, and for riding, driving, &c., in the dust, wind, &c.; the glasses are *large* and shaded, blue, grey, green, and neutral tint; the best mounting for them being fine steel, being the lightest, and attaching firmly to the head.

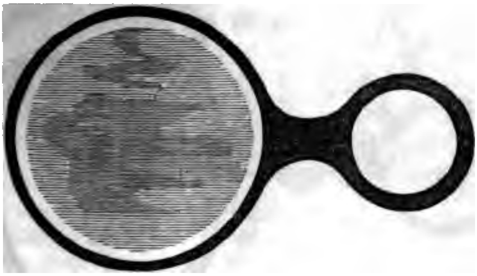
Price, of best quality, - -	$5.00.
" 2d " - - -	$4.50.
" commoner, - - -	$2.50.
" with ordinary size glasses,	$1.50.

Spectacle Cases.—(Fig. 639.)—The cut in the previous page represents the usual style of the morocco spectacle case. They are also made soft, with one or both ends open, and occupying but little space in the pocket, but not protecting the spectacles, as the one represented in the cut. They are made of a variety of colors, but most usually red and dark blue. Price, 12½cts.

Single Eye Glasses.—Eye glasses are frequently used instead of spectacles, being less formal and more convenient for occasional purposes, as in reading a letter, viewing any object for a moment, either near or distant as the case may require. They are mounted in a variety of setting, black horn, tortoise-shell, fine steel, silver, and gold (those in tortoise-shell being the most used), and are worn suspended from a guard around the neck.

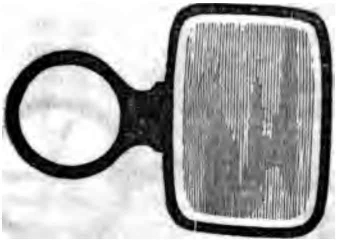
Round Shell Eye-Glass.—(Fig. 640.)

Fig. 640.



Price, round shell eye-glass,	$1.00.
" black horn eye-glass,	63 cts.

Fig. 641.

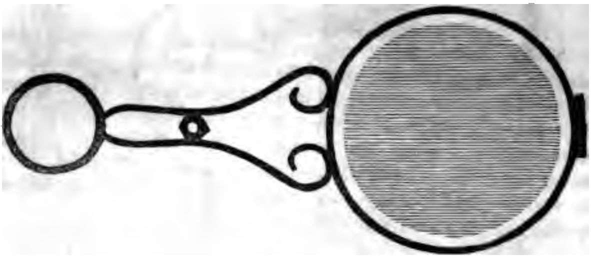


Square Shell Eye-Glass. (Fig. 641.)

Price, square shell eye-glass, $1.
" square black horn, 75 cts.

Fine Steel Eye-Glass.—(Fig. 642.)

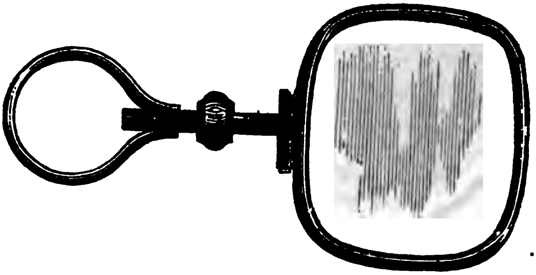
Fig. 642.



Price, $1 to $1.25.

Gold-mounted Eye-Glass.—(Fig. 643.)

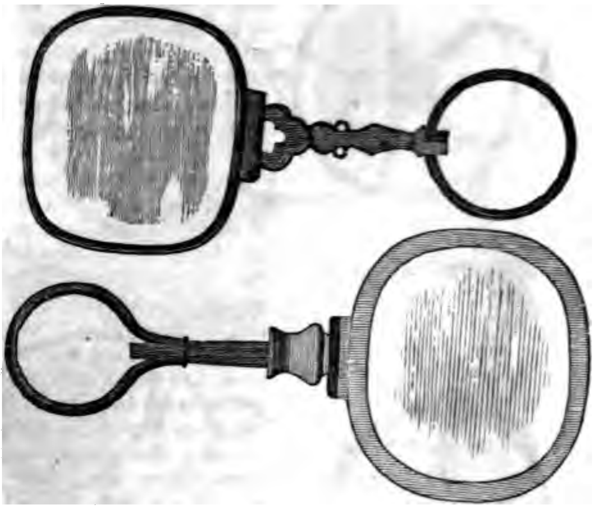
Fig. 643.



Price, $8.00.

Gold-mounted Eye-Glasses.—(Fig. 644.)

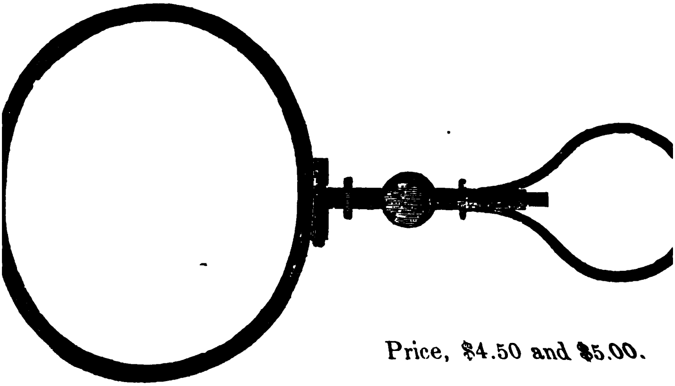
Fig. 644.



Price, $5. each.

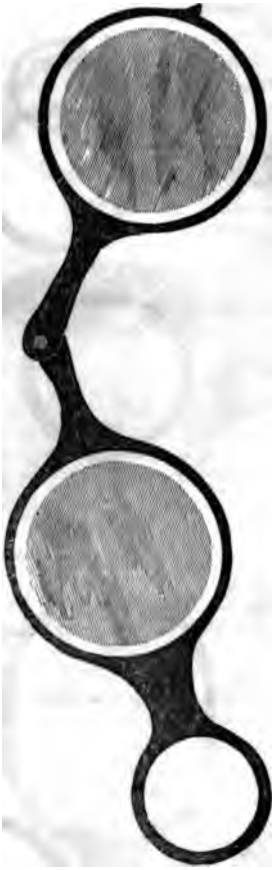
Gold-mounted Reader—(Fig. 645)—which may be held between the eye and object, the lens being larger than the eye-glass

Fig. 645.



Price, $4.50 and $5.00.

Fig. 646.



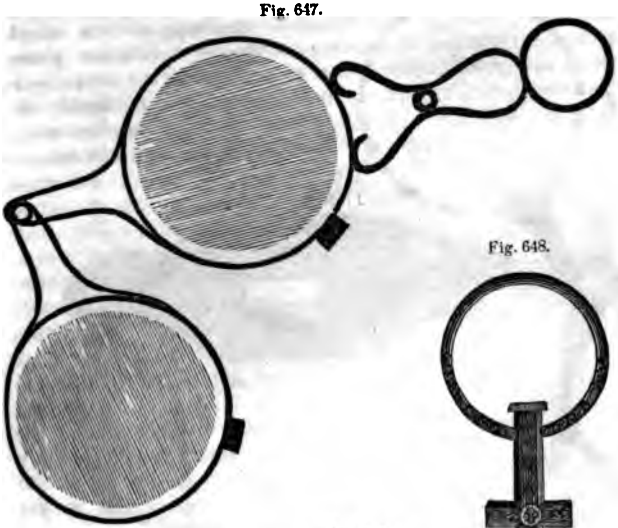
Double Eye Glasses.—Double eye glasses are rapidly superseding the use of the single eye glass; persons seeing more and better with two eyes than with one. Single eye glasses have a tendency to weaken one eye, as the wearer will invariably apply the glass to one eye more than the other, and thereby induce a difference in them. The wearer of a double eye glass will also see better for a longer time, and with more pleasure to himself, than with a single eye glass. They are mounted in black horn, tortoise-shell, fine blued steel, silver, and gold; most of which may be fixed on the nose by slightly pressing the glasses nearer to each other, when the wearer may have the advantage of using both hands if required.

Tortoise Shell Double Eye Glass.—(Fig. 646.)

Price, in black horn, $1.00.
and $1.25.
" tortoise-shell, $1.75.
" " "
with spring, $2.25.
to - - $3.00.

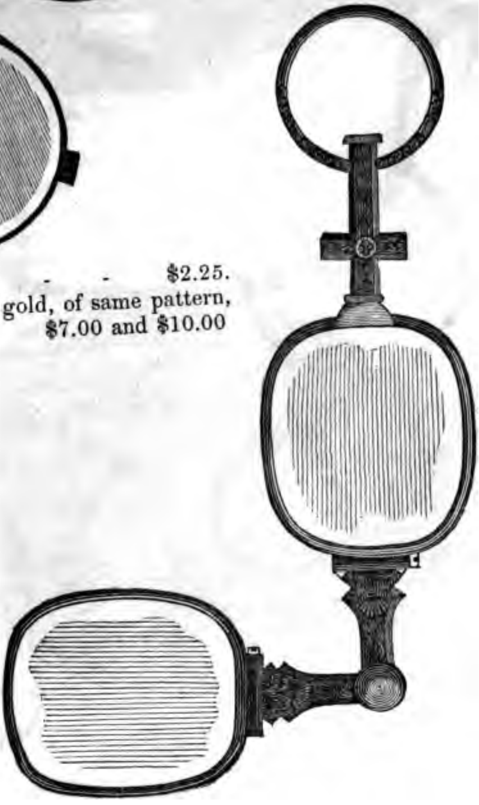
Fine Steel Double Eye Glass.—(Fig. 647.)

Fig. 647.



Price, - - - $2.25.
" solid gold, of same pattern, $7.00 and $10.00

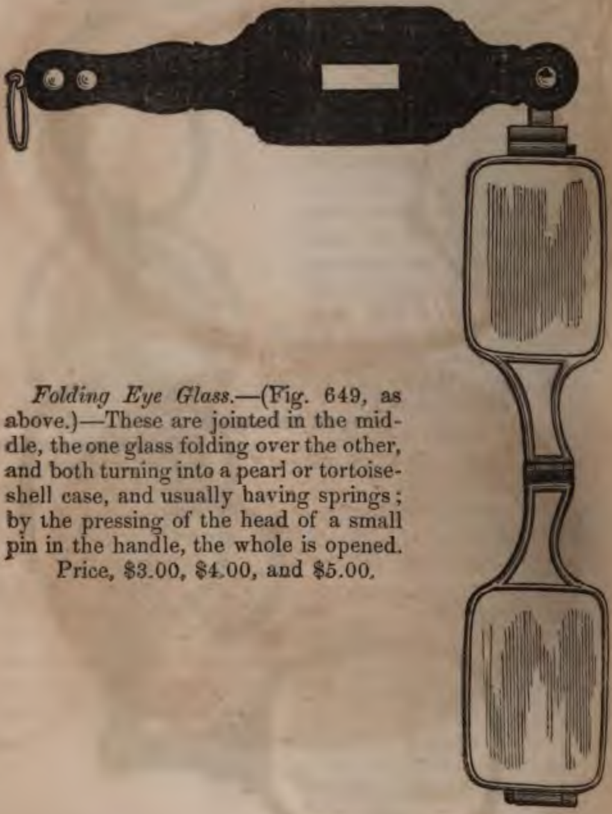
Fig. 648.



Double Eye Glass in Gold.—(Fig. 648, previous page.)—These eye glasses are made in a variety of elegant forms, some having springs, and by touching the head of a small pin in the handle, the spring is loosened and the glass opens; others are formed for supporting on the nose by a slight pressure. This description of eye glass is not made of solid gold, but of a thickness sufficient for the roughest use.

Price, \$5.00, \$6.00, \$7.00, and \$10.00.

Fig. 649



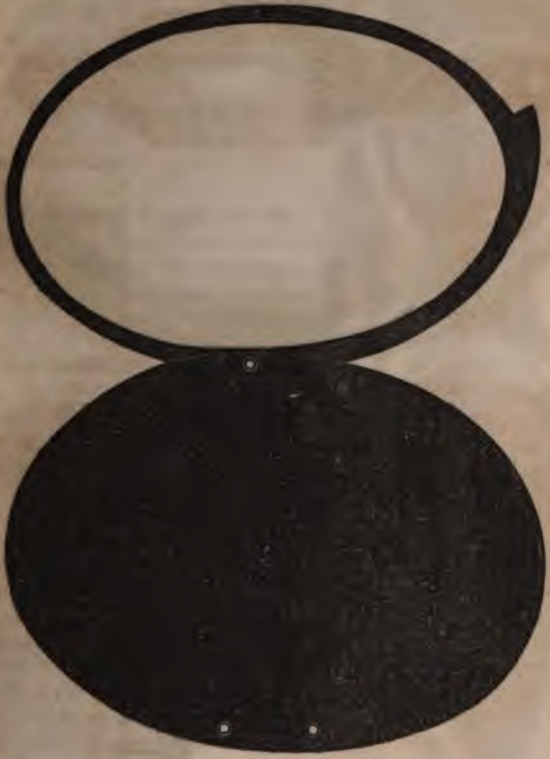
Folding Eye Glass.—(Fig. 649, as above.)—These are jointed in the middle, the one glass folding over the other, and both turning into a pearl or tortoise-shell case, and usually having springs; by the pressing of the head of a small pin in the handle, the whole is opened.

Price, \$3.00, \$4.00, and \$5.00.

Horn Mounted Readers—(Fig. 650)—Consists of a large onvex glass set in a horn frame, folding into a case of the ame material, and are used for reading, &c., held in the and, midway between the object and the eye, but a slight novement of the hand being made. The drawing represents he usual size of the article.

Price, $2.00 ; smaller size, $1.50 and $1.00.

Fig. 650.



Silver and Pearl Mounted Reader.—(Fig. 651.)—This is a substantial and neat made silver frame, containing a large convex lens mounted to a case of tortoise-shell, or pearl, by ornamental plates of silver, and turning on a pivot into the case. The cut represents the full sized reader.

Price, $10.00 ; smaller size, $8.00 and $6.00.

Fig. 651.

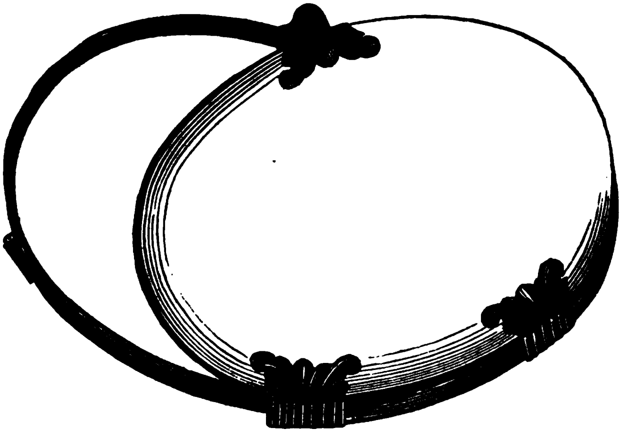
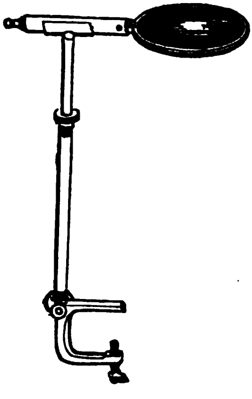


Fig. 652.



Videoscope.—(Fig. 652.)—An optical instrument for drawing, reading, sewing, or any particular work, having a clamp to screw to a table, with a joint and sliding tube for adjustment (the tube may be made fast by screwing the nurled nut on it), so that the lens may be fixed in a convenient position, either leaning over the table or projecting from it.

Price, $5.50.

Goggles (Fig. 653) are used by persons having weak eyes, in riding, driving, or walking, as a protection against the wind, dust, light of the sun, or large surfaces of water, snow, &c. They consist of glasses, white or shaded, usually with plain surfaces, set in silver plated, or black horn rims, and mounted in leather at a proper distance to be supported before the eyes by strings passing round the head.

Price, 75 cts. and $1.00.

Wire Gauze Goggles, or Eye Protectors.—These are an excellent protector for the eyes, and are a great improvement on the ordinary goggles, preventing the heating of the eye by the contact of the leather mounting in the old kind, and allowing the evaporation from the surface of the eye to pass off unobstructed, and as a shade to the eye, will be found serviceable and agreeable. They consist of an oval shaped frame of wire, formed to fit closely around the eye, having caps of fine iron wire gauze, covered with a dull varnish, of sufficient size and convexity to allow the eye-lashes to move freely and unobstructed therein, and supported by strings passing round the head. The effect on the eye being about the same as having a thick veil before it,

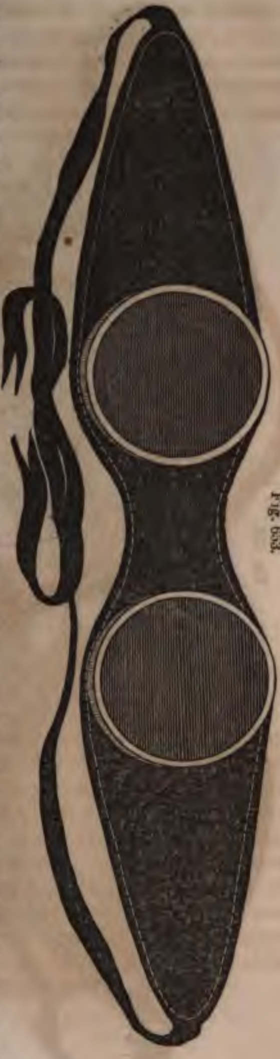


Fig. 653.

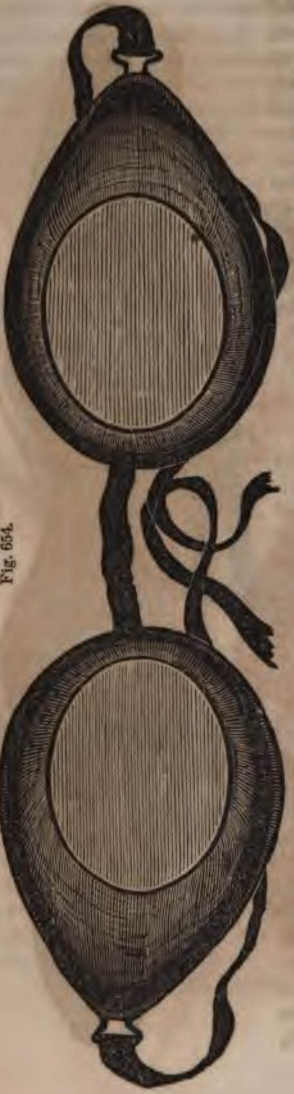


Fig. 654.

taking off the glare of light, but allowing objects to be seen with distinctness, also keeping of all dust and wind, that would injure the eye, even in a weak state, without destroying that ventilation necessary for the health of the eye. They are also particularly serviceable in riding in rail-road cars; the sparks from the cinders frequently occasioning serious accidents by their falling in the eye, which the use of these will prevent.

Price, $1.00.

(Fig. 654.)—They are also set with glasses in the centre of the cup, as represented in the cut, which may be white, or shaded blue, grey, or green; either convex, or concave, but usually with plane surfaces, neither magnifying nor diminishing.

Price, $1.00 and $1.25.

Goggles for Squinting.—(Fig. 655.)—These goggles are instruments used for curing squinting, or that distortion of the eyes which occasions this disorder; they are short conical cups of ivory, horn, or hard wood stained black. Through the centre of each of these cups is a small circular hole, about the size of the pupil of the eye, for the transmission of the rays of light. They are mounted in a leather frame, and worn continually in the day time, till the muscles are brought to act regularly and uniformly, so as to direct the pupil straight forwards; and by these means the cure will be sooner or later effected. Price, 88 cts.

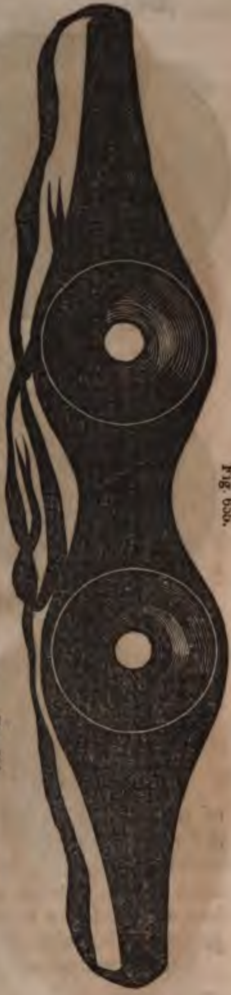


Fig. 655.

Fig. 656 is an improved mounting for the above, in wire frames, preventing the heating of the eye by the leather mounting.
Price, $1.50.

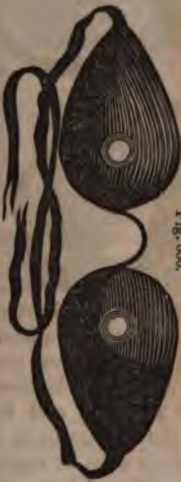


Fig. 656.

Fig. 657

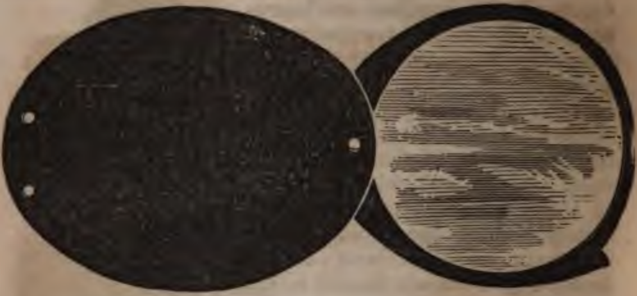


Fig. 658.

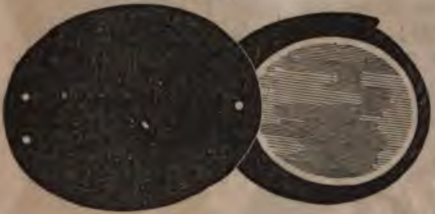
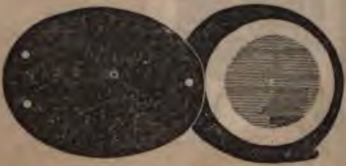


Fig. 659



Magnifier.

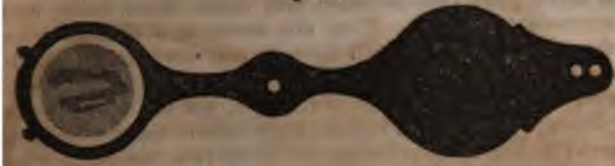
The common magnifying glass or simplest kind of microscope is nothing but a converging lens of very short focus. This instrument enables us to see objects which could not possibly be seen by the unassisted sight. The botanist detects by means of it the delicate organs of plants, and workmen in every department of the arts use it for minute adjustments and operations.

(Figs. 657, 658, and 659.)—These are variously mounted, most usually having a rim of black horn, turning on a pivot into a box of the same material, and having a slight projection on one side of the rim, to open it conveniently.

They are made of three sizes as represented in the cuts.

Price, 75 cts., 50 cts., and 44 cts.

Fig. 660.



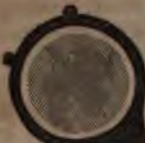
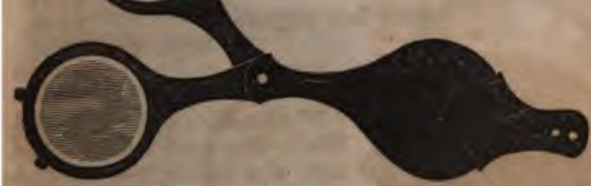


Fig. 661.



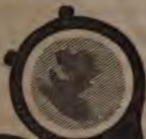
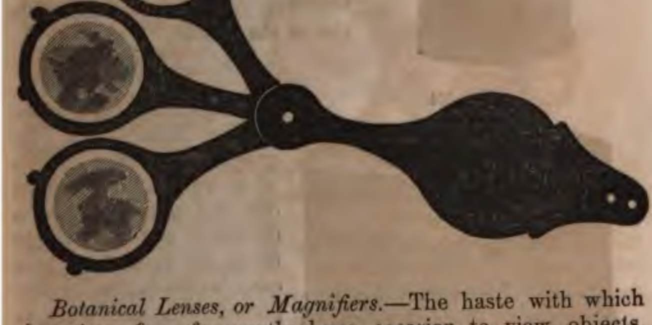


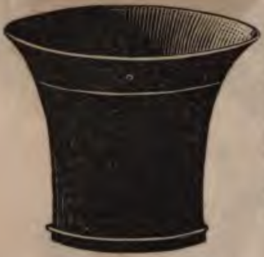
Fig. 662.



Botanical Lenses, or Magnifiers.—The haste with which botanists, &c., frequently have occasion to view objects, renders a pocket magnifier very useful. The most convenient of any constructed are those represented in Figs. 660, 661, and 662, which are drawn of the medium size, there being *a size smaller* and one larger; this form of mounting is much preferable to those with round cases, being more convenient to hold. They are made with one, two, and three lenses. Those with three frames are usually set with one, one and a half, and two inch focus lenses; they all turn over each other and shut in the case, and are turned out at pleasure. The three lenses singly, afford three magnifying powers, and by combining two and two, we make three more, and all three together, one more, making seven different degrees of magnifying with the three glasses only.

Price, single lens magnifier,	- -	$0.62.
" " "	larger size,	$0.75.
" double "	- - -	$1.00.
" " "	larger size,	$1.12.
" treble lens magnifier,	-	$1.38.
" " "	larger size,	$1.50.

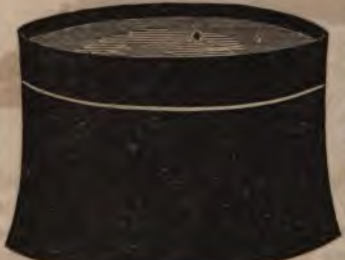
Fig. 663.



Watchmaker's Magnifier.—(Fig 663.)—The watch magnifier consists of a convex lens of about two inches focus, set in a deep horn case, the larger end of which is of such a size and form, as to be held between the eyebrow and bone of the cheek without inconvenience. The cut represents the size of the article.

Price, 38 cts.

Fig. 664.

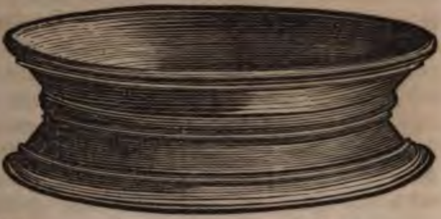


Engraver's Magnifier.—(Fig. 664.)—The engraver's magnifier consists of a convex lens, about one and a half inches in diameter and two inches focus, set in a deep horn case, which is usually supported over the work to be engraved by a suitable stand; the eye viewing the work through the lens while engraving.

Price, 75 cts.

graver's Magnifier (Fig. 665), larger size, in cocoa
frame.

Fig. 665.



ce, $1.00

ra large,
$1.75.

Fig. 666.

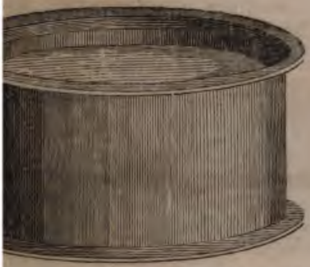
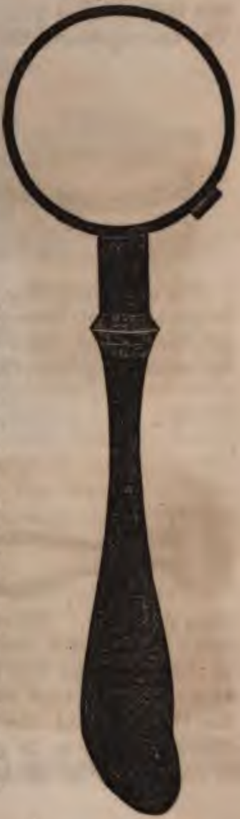


Fig. 667.

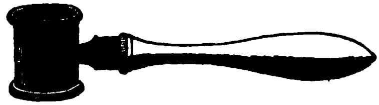


graver's Double Lens Magnifier.
ç. 666.)—The engraver's dou-
ens magnifier consists of two
-convex, or periscopic lenses,
ted with their convex sides in-
in a brass frame, the cells
ewing to clean the glasses oc-
ially. This construction of
ifier is preferable for persons in
int use of these glasses, and
ius of straining their eyes as
as possible in the use thereof,
being less spherical aberration
lenses thus arranged than in
s. Price, $1.50 and $1.75.

nd Magnifiers.—(Fig. 667.)—
consists of a convex lens, mount-
a *metal frame,* and attached to
handle, by which it may be

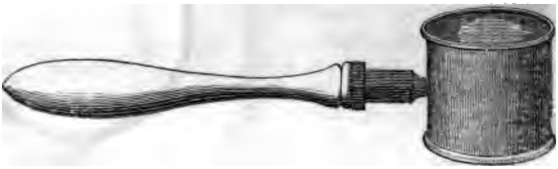
held for viewing any object, and is well suited for viewing daguerreotypes. Price, 75 cts.

Fig. 668.



Double Lens Hand Microscope, or Doublet.—(Fig. 668.)—This is the most powerful instrument, for the price that it is sold for, that is to be obtained. It consists of two plano-convex lenses, with the plane surfaces outwards, mounted in cells and screwed in a frame having an ivory handle; where a person has skill to use a great power, this is a desirable instrument. The cut represents the size of the article. Price, $1.00.

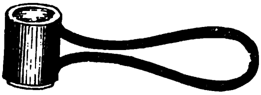
Fig. 669.



The above cut (Fig. 669) represents the same article of a larger size, not having so great a magnifying power, but a greater field of vision; it may be used with one lens only, by unscrewing the other.

Price, in brass mounting, $0.75.
" in German silver, $1.00.

Fig. 670.



Stanhope Lens.—(Fig. 670.)—This simple but very powerful lens is the invention of Lord Stanhope; both ends are ground convex, the one next the eye rather more so than the other. It has many advantages over the common lens: for instance, the difficulty of holding the hand steady to the focus, and the loss of light and field attendant on viewing with a high magnifying power, are here obviated; for, the length of the cylinder being the exact focus, the *object* has only to be placed upon the end that is ground less convex, or to be brought in contact with it, when the dvantage of great magnifying power will be obtained, with field nearly equal to many of the compound microscopes. The portability of this instrument, its low price, and the acility with which it can be used, must recommend it trongly to all who use microscopic lenses. With it may be iewed the animalcules in water, mites in cheese, eels in aste and vinegar, the perspiration, human hair, farina, and aves of flowers, the hairs of animals, the down of moths, c.; and if a single drop of the crystallization of salts be pread lightly over the end of the lens, and viewed without elay, the formation of the crystal will be beautifully apparent. Price, $2.00.

Fig. 671.

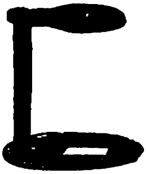
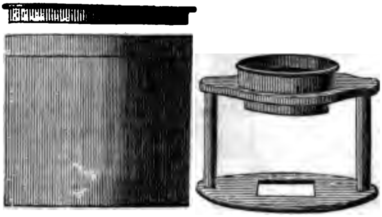


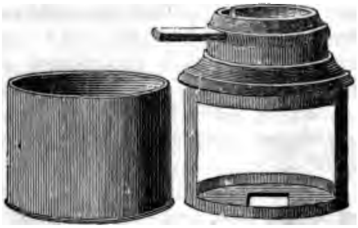
Fig. 672.



Linen and Cloth Prover.—(Figs. 671 and 672.)—This intrument for ascertaining the fineness of linens, muslins, olting cloths, &c.; by ascertaining the number of threads n a given space under a powerful magnifying glass, consists f a lens mounted in a brass frame, about one inch over a quare hole that is exactly half, or quarter of an inch square, nd situated in the focus of the lens. The hole is placed on he linen, or fabric to be examined, and held in a position to eceive a strong light, when it will appear, on viewing hrough the lens, magnified to such an extent that the umber of threads in the space may readily be counted, and he fineness thereby accurately ascertained. This instruent will answer the purpose of magnifying small objects, laced on the top of the plate, equally well. They are nclosed in small round boxes of wood or brass.

Price, in wood box,	- -	63 cts.
" in brass "	- -	75 cts.
" " "	extra finish,	88 cts.

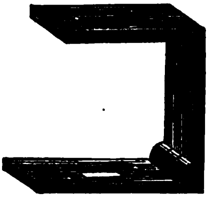
Fig. 673.



Slide Head Linen Prover.—(Fig. 673.)—This arrangement has a slide covering the glass, which is opened by a small pin at the top, the lower part of the frame being a tube with portions of the sides cut out, and covered by a brass cap when not in use.

Price, $1.00.

Fig. 674.



Folding Linen Prover.—(Fig. 674.)—The folding linen prover is formed of a brass or German silver frame, the best having a steel spring at the back; the top and bottom jointed to allow them to be turned close down on each other, and when closed occupy but a space of a quarter of an inch in thickness, half an inch in breadth, and one in length, and is very convenient for the pocket.

Price, plain brass	mounted,	$0.75.
" best "	"	$1.25.
" " German silver	"	$1.50.

Fig. 675.

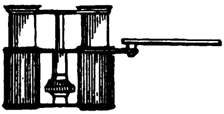
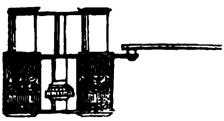


Fig. 676.

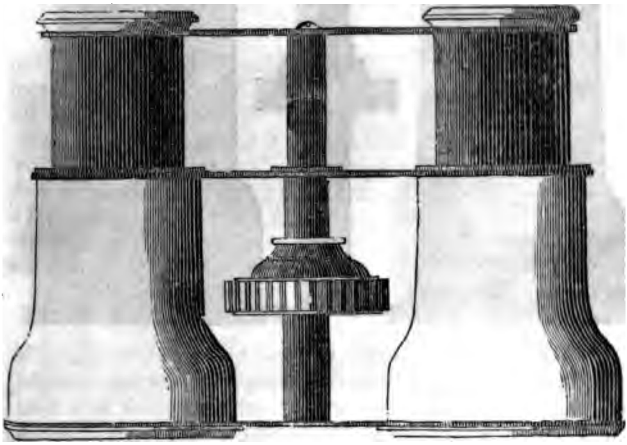


Opera Glass.—The opera glass is a Galilean telescope, with a large object glass, and usually more expensively mounted than the ordinary instrument. The best have achromatic object glasses; they are mostly used of late arranged for both eyes, having between the tubes for containing the glasses, an adjusting screw, with a roller milled on the edge, by the turning of which, the glasses may be easily moved to the distance required for perfect vision. They are mounted in metal bodies, which are japanned black, or in gilt, ivory, pearl, or tortoise-shell, many of which are highly ornamental, and may be used with great advantage in public lectures for viewing illustrations and experiments, as well as for the more common use at theatres.

Price, in plain mounting (Fig. 675), - $2.50.
" ornamental, " (Fig. 676), $3.50 to $5.00.
" " " with larger object glass, $7.00.

Ivory and Gilt Mounted Opera Glass.—(Fig. 677.)

Fig. 677.

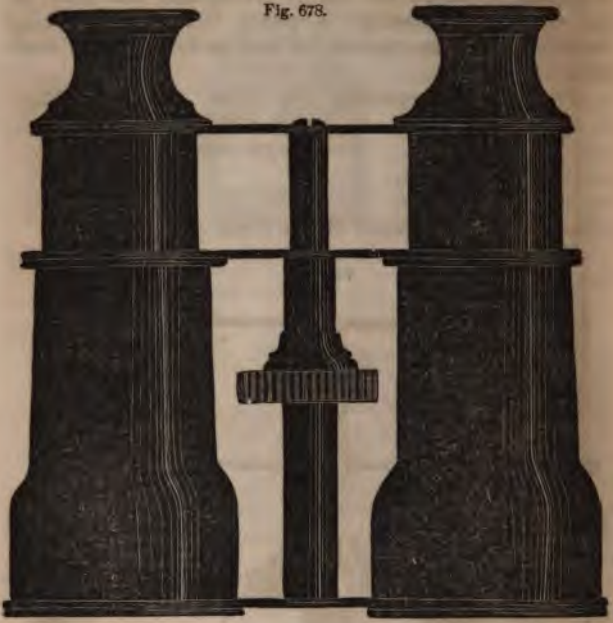


Price, - - - $ 8.00.
" large size, $10.00 and $12.00.

Black Mounted Opera Glasses.—(Fig. 678, next page.)—These are constructed of ivory, blacked and highly polished, tortoise-shell, or metal japanned, either with the tubes gilt or entirely black.

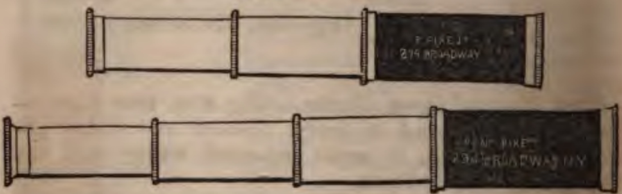
Price, plain mounting japanned, $5.50 to $9.00.
" with best achromatic lenses, $9.00 and $10.00.
" white or black ivory, $13.00 and $16.00.
" *tortoise-shell,* - - $20.00 and 25.00.

Fig. 678.



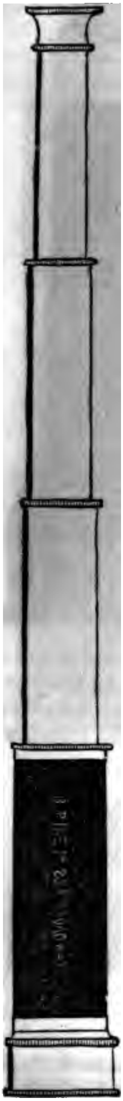
Galilean Telescope.—(Figs. 679 and 680.)—This consists of a single convex glass, whose focal length is from four to eight inches for an object glass, and a double concave lens from a half to two inches focus for the eye glass. The distance between the two glasses is equal to the difference of their *focal* lengths, and their power is in the ratio of their foci. They are usually mounted in brass cases, japanned on the outside, having one, two, or three draws on slides, which are

Figs. 679 and 680.



drawn out till the object is quite distirct, different distances requiring a slight alteration in the length. Price, 1 draw, 50 cts; 2 draws, 75 cts; " 3 draws, $1.00.

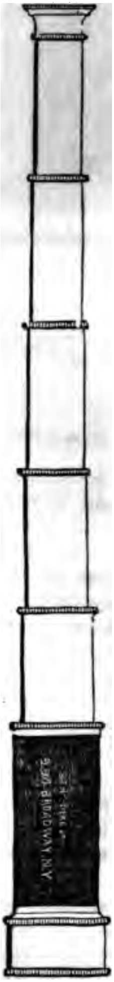
Fig. 681.



Pocket Achromatic Telescopes.—(**Fig**. 681.)—These telescopes are **mounted** with mahogany body, **having** an achromatic object glass, **and brass tubes,** on sliders drawing out three times. The eye piece contains four lenses, and are instruments of considerable power. **They are** made of sizes from sixteen to thirty inches in length **when** drawn out, and from six to **ten** inches when closed.

Price, 16-inch 3-draw achromatic telescope,	$4 to $6.
" 22-in. 3-draw "	$6 to $8.
" 30-in. "	$10 to $.12

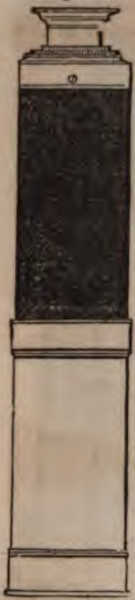
Fig. 682.



Military Telescope.—(Fig. 682.)—The military telescope is an instrument of the best construction and made in the most portable manner, having five to eight slides, and folding up in a small compass; when used for military purposes is inclosed in a leather case, having a belt for suspending it over the shoulder. They are made of various sizes, from fifteen to thirty-eight inches in length when drawn out, closing up to from four to ten inches in length.

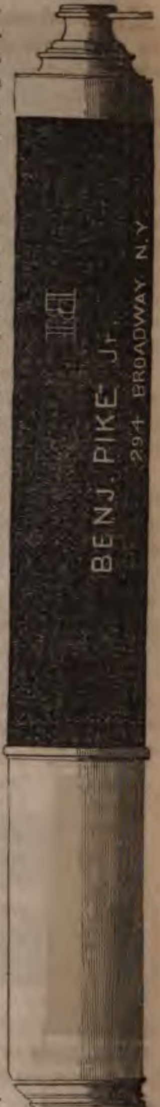
Price, 15-in. 6-draw military telescope,	$7.50.
" 20-in. 6-draw "	$10.
" 24-in. 6-draw "	$20.
" 38-in. 4-draw "	$15 and $20.

Fig. 683.



Military Telescope.—(Fig. 683.)—This cut represents a military telescope, the tubes closed, having a sun-shade tube, the extra cost of which is from 50 cts. to $1.50, according to size.

Fig. 684.

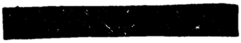

BENJ. PIKE Jr.
294 BROADWAY N.Y.

Achromatic Ship Telescope.—(Fig. 684.)—The achromatic ship telescope, represented in the cut, is employed very extensively both on the land as well as at sea, in viewing distant objects. The full length of this telescope, when drawn out, is 3 feet, and when closed 21 inches if with a single draw; 15 inches if with two; or 12 inches if with three. Those with one draw are preferred, having larger glasses in the eye-piece. The case is two and a half inches, and is usually of mahogany covered with bridle leather in the best instruments, and having a sun shade at the end for the object glass, which is also used at sea to protect the glass from the spray. This instrument is sometimes called a day and night telescope, from its being suited to use at night as well as in the day; this is of most use at sea, where it is at times important to see at night an object only partly discerned by the naked eye. To use the telescope as a night glass the joint furthest from the eye hole is unscrewed, and the tube containing two lenses taken out; the telescope will now represent objects in an inverted position, but they will appear more distinct than with the naked eye.

Price, common make, - - $ 7.00.
" best glasses, $9.00 and $10.00.
" leather body, $11.00 and $12.50.

Lenses.—A plane glass (Fig. 686) has two plane surfaces parallel to one another.

Fig. 686.

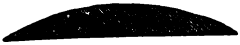


A double convex lens (Fig. 687) is bounded by two convex spherical surfaces, whose centres are on opposite sides of the lens. It is equally convex when the radii of both surfaces (that is, the distances from the centres to the circumferences of the circle they belong to) are equal, and unequally convex, when their radii or distances are unequal.

Fig. 687.

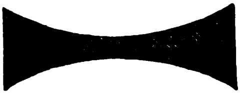
A plano-convex lens (Fig. 688) is bounded by a plane surface on one side, and by a convex one on the other.

Fig. 688.



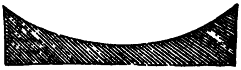
A double concave lens (Fig. 689) is bounded by two concave spherical surfaces, whose centres are on opposite sides of the lens.

Fig. 689.



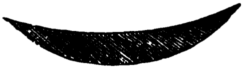
A plano-concave lens (Fig. 690) is bounded by a plane surface on one side, and a concave one on the other.

Fig. 690.



A meniscus (Fig. 691) is bounded by a concave and a convex spherical surface; and these two surfaces meet, if continued.

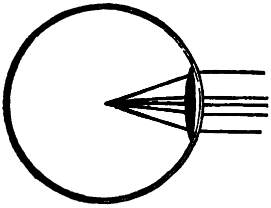
Fig. 691.



Price,	plane glass, - - - -	12 cts.
"	double convex lens, . - -	38 cts.
"	double concave "	38 cts. to 62 cts.
"	plano-convex "	50 cts. to 62 cts.
"	plano-concave "	50 cts. to 62 cts.
"	meniscus, - - - - - -	50 cts.
"	set of six lenses, - - -	$1.50.

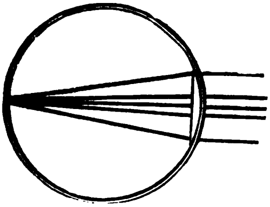
Models to show the focus of a Lens.—This is an arrangement of wires as represented in the cuts (Figs. 692 and 693, next page), as having a wooden disc in the form of a lens, through which the wires pass, representing the rays of light converging to a focus; the whole handsomely japanned.

Fig. 692



Model of Double Convex Lens and Rays Converging. — (Fig. 692.)—The focal distance, or distance of the focus from the surface of the lens, depends both upon the form of the lens and of the refractive power of the substance of which it is made; in a glass lens, both sides of which are equally convex, the focus is situated nearly at the centre of the sphere, of which the surface of the lens forms a portion; it is at the distance, therefore, of the radius of the sphere. Price, $1.00.

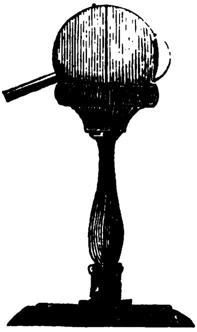
Fig. 693.



Model of Plano-Convex Lens and Rays Converging. — (Fig. 693.)—Lenses that have one side flat and the other convex, are called plano-convex, and their focus is at the distance of the diameter of a sphere, of which the convex surface of the lens forms a portion, as represented in the model. Price, $1.00.

Models of the Eye.—(Figs. 694, 695, 696, and 697.)—These consist of four instruments, and form a beautiful arrangement for showing the structure of the eye, and the nature of vision; they are usually sold together.

Fig. 694.



Model of the Eye.—(Fig. 694.)—This consists of a globe four inches in diameter, and when the various parts are put together representing the eye; in front is represented the cornea, and nearly on an opposite part the optic nerve. This globe is formed of two hemispheres, the one fitting within the other for a small space, so that they may be separated easily; within are parts representing the different coats and humors of the eye, in a clear and distinct manner;

in all, ten different parts, viz., the crystalline lens, vitreous humor, cornea, retina in two parts, black pigment, choroid or fleecy coat, iris, sclerotic or hard coat, optic nerve. The first three are formed of glass, the other parts are of wood, japanned and polished in appropriate colors, the whole supported on a neat mahogany stand. Price, $5.00.

Fig. 695.

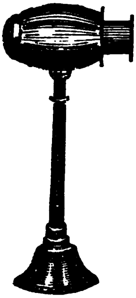
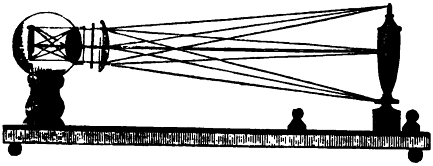


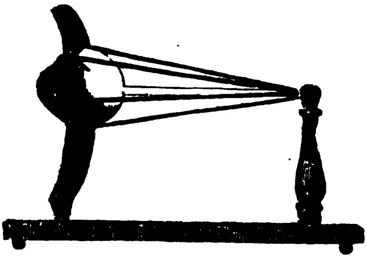
Image on the Retina.—(Fig. 695.)—This consists of a hollow ball four inches in diameter, representing the globe of the eye, having inserted on one side a lens in a brass cell, representing the lenses of the eye; on the opposite side of the ball there is a sliding tube having on one end a ground glass. When the lens representing the eye is held towards any object, the inverted image may be seen on the ground glass; and by placing a concave or convex lens in front of the lens in the instrument, the effect of long and near sighted vision is beautifully seen. Price, $2.50.

Fig. 696.



Instrument to show the nature of Vision.—(Fig. 696.)—This instrument is mounted on a neat mahogany base thirteen inches long, on which is supported from a short pillar. a glass globe, four inches in diameter, having an opening on two sides, about two inches wide; in one of these apertures are represented the outer lenses of the eye; near the other end of the base is an object, about six inches high, which is movable for about two inches, being fixed on one side. To the object are attached nine silken strings, of different colors, representing rays of light, and passing through holes in the lenses of the eye, are united to an inverted image of the object, at the place of the retina. The whole arrangement of strings attached to the erect object, and crossing at the lenses of the eye and uniting the inverted object, may be moved beyond the retina, as in the long-sighted eye; or within the retina, as in the near-sighted eye; or when placed at the retina, perfect vision; thus explaining, in a clear manner, those positions of the image in regard to the retina. - Price, $6.00.

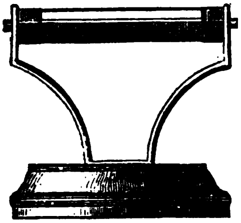
Fig. 697.



Muscles of the Eye.—(Fig. 697.)—This instrument represents the globe of the eye revolving in its socket, and consists of a ball, about four inches in diameter, having attached to it stout pieces of tape, representing its four straight and two oblique muscles, having their proper names attached; also showing the beautiful arrangement of the oblique muscle near the nose, giving a correct idea of that wonderful arrangement in the human frame. The ball of the eye may be moved in all directions. The whole is mounted on a neat mahogany stand, about 12 inches long.

Price, - - - -	$2.50.
" or the whole set, -	$13.00.
" first, third, and fourth,	$11.00.

Fig. 698.



The Prism. — (Fig. 698.)—A triangular piece of glass employed to separate a ray of light into its constituent parts or colors by refraction. The prism is the instrument by which the most remarkable phenomena of light and colors are exhibited. To use the prism, let a room be darkened, and the sun permitted to shine into it through a small hole in the window shutter, it will give a circular white spot; but let it be made to fall on the glass prism, then will the sun's rays in passing through the prism suffer different degrees of refraction, and *by that* means be parted into different rays, which being *received* upon a sheet of white paper will exhibit the following colors, viz. red, orange, yellow, green, blue, indigo, and violet; and if the whole spectrum or image be divided into 360 equal parts, the red will occupy 45 of them, the orange 27, the yellow 48, the green 60, the blue 60, the indigo 40, and the violet 80.

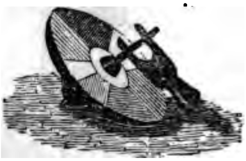
Place the prism horizontally near the eye, with one of its faces upwards so as to receive the light that enters on the opposite face, and the following remarkable phenomena will be observed; the light will have undergone considerable deviation, so that all objects will appear elevated towards the summit of the prism, and will appear colored at their edges with all the colors of the rainbow. If the face of the prism is downward the objects will be displaced downward. If the prism be placed vertically, the deviation will take place to the right or left as the position is altered.

Price, 38 cts.; $1.00; $1.50; $2.00 and $3.00.
" mounted (Fig. 698), $2.00 to $5.00.

Compound Prisms.—Prisms are sometimes formed of different kinds of glass, as crown, flint, and plate glass, for showing their different refractive powers.

Price, $3.00.

Fig. 699.



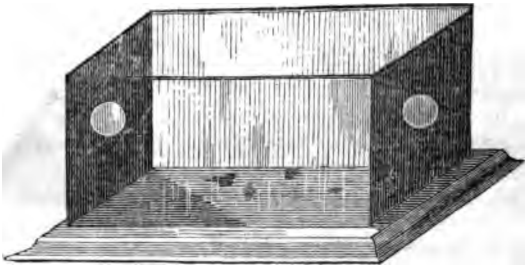
Instrument for the Recomposition of Light.—(Fig. 699.)—This instrument for the recomposition of light, sometimes called a color blender, is conveniently formed in the shape of a large top, about five and a half inches in diameter, which, by means of a string and handle, may be rapidly spun around for a considerable time. On the surface of the top there is accurately described the proportion of the different colors, which are engraved on a plate, near the centre, while the exterior is filled with colored papers, each color of nearly the color of the spectrum, and occupying the same proportion, viz. violet 80, indigo 40, blue 60, green 60, yellow 48, orange 27, red 45; the whole is varnished to protect it from injury.

As the rays of the sun may be separated into these seven primitive colors, so, by their mixture in due proportions, may white be *produced*. White, therefore, is the mixture of all the colors, as black is the want or deprivation of color; which may be proved by this instrument.

Though seven different colors are distinguishable in the prismatic spectrum, yet, upon examining the matter with more accuracy, we shall see that there are, in fact, only three original colors—red, blue, and yellow, for the orange being situated between the red and yellow, is only the mixture of these two; the green, in like manner, arises from blending the blue and yellow, and the violet results from the blue and red. Price, $1.00.

Glass Box for Experiments on Refraction.—(Fig. 700.)—This consists of a metallic box, open at top, from 8 to 14 inches long, and from 5 to 9 inches wide, having true plate-glass sides. Each end has a circular aperture, about 2 inches wide, the one having a meniscus glass with the convex surface outwards, and the other having one with the concave surface outwards. The box is made water-tight, and is usually supported on a neat base, and furnished with a cock, for the more easily emptying it of water.

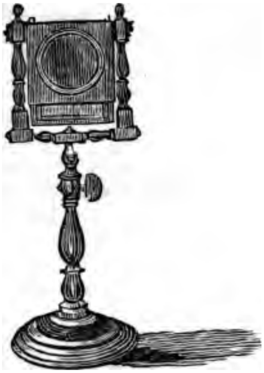
Fig. 700.



To use it, cause a ray, or pencil of light, from a hole in the window, to fall on the bottom of the box, where you may make a mark; then fill the box with water, without moving it out of its place, and you will see that the pencil of light, instead of falling on the mark, as before, will be refracted, or bent out of its former course. A few drops of milk added to the water will make the course of the ray of light more distinct. If a small mirror be laid on the bottom *of the box* when filled with water, the light will be reflected *from it, and* will be observed to suffer the same refraction as in coming in, only in a different direction. Place the box so that a pencil of light falls directly on the convex glass, at the end; as soon as water is poured in the box, the rays converge and meet in a point; cause the pencil of light to fall on the concave glass, and the rays diverge, and the pencil of light is enlarged. Many other experiments illustrating refraction, and the passage of light through lenses, may be illustrated in a beautiful manner by this instrument.

Price, $4.00 and $5.50.

Fig. 701.



The Optical Diagonal Machine, Print Glass, or Cosmoramma (Fig. 701), consists of a convex lens from four to six inches in diameter, mounted in a square frame, and supported by an ornamental framework resting on a round pedestal, in the column of which is a slide, and a screw to fix it any height required to view the print with the best effect; behind the lens is a frame, with a mirror considerably larger than the lens, which is jointed at the top, and may be supported at a proper angle by a wire for the purpose. The prints are laid on the table, and viewed in the mirror through the lens, producing a very deceptive appearance, and in imagination bringing the reality before you. The frame is of polished wood, and may be taken apart by unscrewing for convenient transportation.

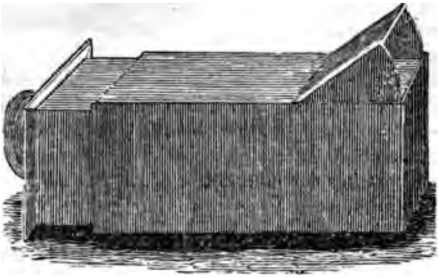
This instrument, used for magnifying prints, is neat in its appearance and useful in its application; pictures are very interesting to children, and give them a very just idea of the relative size and distance of objects; they also teach them accuracy of sight, engage their imagination, and fix their attention, promoting many inquiries, which, if judiciously answered, will store their minds with useful information.

Good perspective views designed for this instrument, handsomely colored, fourteen inches by twenty-two in size, embracing views of many of the most celebrated public buildings of the principal cities in Europe, interiors of public buildings in Rome, London, &c., views of shipping, landscape views, &c., to the number of one hundred and upwards, may be obtained with the instrument, for the low price of eight cents each, which is not one half the price usually charged.

Price, diagonal print glass with 4 inch lens,	$2.75.
" " " " " 5 " "	$3.25.
" " " " " 6 " "	$3.75.
" prints, 14 by 22 inch, per dozen,	$1.00.
" " " " " " hundred,	$8.00.

The Portable Camera Obscura.—(Fig. 702.)—This consists of a box usually about twelve inches long, having one end attached to a movable slide, which may be drawn out a few inches, in which is fixed a convex lens, of a suitable focus; within the box is placed diagonally a mirror, so as to reflect the object on a ground glass, occupying nearly half of the top of the box, and over which is hinged a screen or shutter having closed sides, moving within the sides of the box to exclude the external light; on the rough glass external objects are beautifully represented, affording a pleasing amusement to young persons, as representing a moving panorama of animated nature.

Fig. 702.

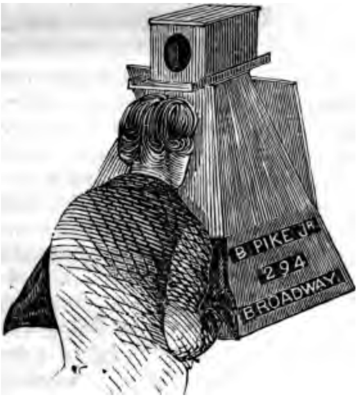


Directions for Use.—Place on the ground glass a piece of good tracing paper, and present the instrument to the object to be copied, which should be strongly illuminated. The camera should be placed level. Draw the slide till the object is reflected on the paper, and if the lines are followed *with a pencil*, a correct copy of the view will be obtained. *If a portrait* be desired, the person should be placed in the proper position, in a strong light, and the lines traced as above, when a correct likeness may be obtained by persons unacquainted with drawing.

Price, 12 inches long, $3.50.
" 18 " $6.00.

A simple camera obscura may be constructed in the following manner: fix a convex lens, from one to three inches diameter, in the hole of a window shutter, and if no light enters the room but through the glass, the pictures of all objects on the outside may be seen in an inverted position on a sheet of white paper placed at the focus of the glass, or at such a distance from it as they may be represented clear and distinct. Price, 25 cts. to 75 cts.

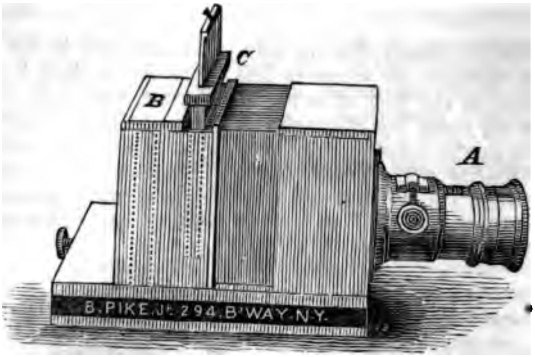
Fig. 703.



Draughtsman's Camera Obscura and Cosmorama. — (Fig. 703.) — This convenient arrangement of the camera when set up is twenty-one inches high, the sides are hinged, and when not in use, may, together with the other parts, be folded down into the case; the usual size being eighteen inches long, fourteen inches wide, and seven and a half inches deep; the larger size being twenty-four inches long, and of proportional dimensions. The lens and mirror, the latter inclined at an angle of 45 degrees, are contained in a box on the top of the case, which may be turned around and directed to any part of the horizon; also having a sliding motion for adjusting the focus. The object is received by the lens, and reflected by the mirror to a sheet of white paper placed on the bottom of the box. One side of the box is cut to admit the head and arms of the person who desires to trace with a pencil the objects delineated. This instrument also forms an excellent cosmorama, by placing prints on the bottom of the box, and viewing them reflected by the mirror through the lens.

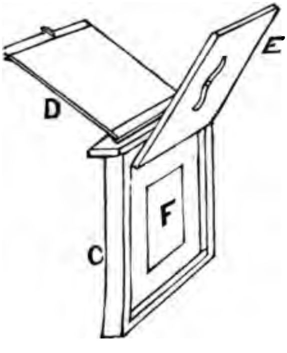
Price, $8.00; extra large size, $12.00.

Fig. 704.


C
B
A
B. PIKE Jr. 294 B'WAY N.Y.

Daguerreotype Camera.—The camera obscura, used for taking daguerreotype pictures (Fig. 704), consists of a mahogany box, on the front of which is fixed a brass sliding tube, A, containing two achromatic lenses. The image is received on a piece of ground glass, fitted in a frame, B, which slides in a groove in the back of the camera, and the focus is adjusted to the greatest nicety by a fine rack-work movement in the brass tube containing the lenses. The frame, B, may be withdrawn, and another frame, C (represented in Fig. 705), introduced, consisting of a box, made to receive thin wooden frames, which are grooved around and adapted for receiving the various sized daguerreotype plates to be used. This frame is furnished with a sliding shutter, D, in front of the plate to prevent the access of light to the plate till placed in the camera. E is a hinged flap with spring to keep the frame and plate in their proper position.

Fig. 705.

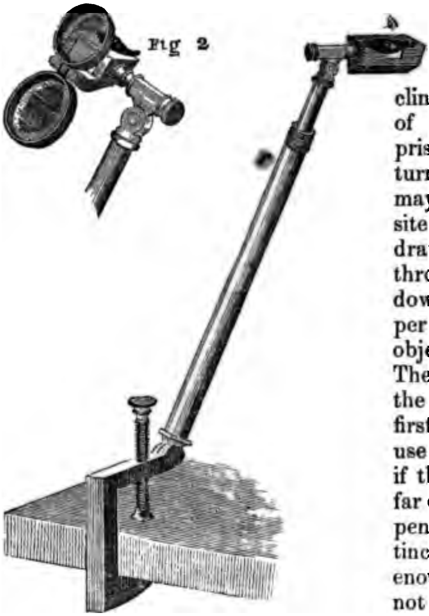


Daguerreotype pictures are taken on copper plates,
ered with a coating of silver of a sufficient thickness to
w of its being finely polished. The method of proceed-
consists of five distinct operations, viz. 1. Cleaning the
ered plate. 2. Rendering its surface sensitive to light
exposing it to the vapor of iodine, &c. 3. Exposing the
pared sensitive plate to the focus of the camera. 4.
nging out the picture by exposing it to the vapor of mer-
y. 5. Setting the picture by removing the sensitive sur-
e of the plate which has not been acted upon by the
it; and lastly, they are sometimes colored, which is done
hand in a manner similar to painting.

Price,	of camera with mahogany or rosewood box,	$25.00.
"	common stand,	$ 4.00.
"	two coating boxes, for coating the plate with iodine and quick stuff, the pair,	$ 4.50.
"	cast iron mercury bath,	$ 1.25.
"	thermometer for mercury bath,	$ 0.50.
"	spirit lamp,	25 cts. to $ 1.00.
"	plate vice, for holding the plate while cleaning,	$ 1.75.
"	buffing stick, for polishing the plates,	$ 0.25.
"	head rest, with arrangements for attaching to a chair,	$ 3.00.
"	box of colors and brushes,	$ 3.00.
"	plates, medium size, 2¾ by 3¼ inches, per dozen,	$ 3.00.
"	plates, quarter size, 3¾ by 4¼ inches, per dozen,	$ 4.50.

amera Lucida.—(Fig. 706, next page.)—By means of
instrument objects are represented on a sheet of paper,
hat an accurate drawing may be made, even by those
e accustomed to the pencil. In sketching from nature
is of the greatest use to the artist; an indifferent
ughtsman may make an accurate drawing of the view
re him. Portraits may be correctly taken the size of
, or in any less proportion. Paintings, prints, maps,
wings of machinery, instruments, furniture, &c., may be
wn *in true perspective* to any required scale.

Fig. 706.



To use, fix the instrument to the table by the screw, with the stem inclined. Place a sheet of paper under the prism, which must be turned, so that the face may be exactly opposite the object to be drawn; by looking through the eye-hole downward on the paper a picture of the object will be seen. The proper position of the eye-hole is of the first importance in the use of the instrument; if the aperture is too far over the prism, the pencil will be indistinct, and if not far enough the object cannot be seen sufficiently clear; a little practice will make this perfectly easy. In first attempting to use this instrument many persons lose sight of the pencil, merely by the motion of the head in breathing, which they are not aware of. The longer the stem is drawn out, the larger the object will appear, and the view less extended. If the object to be drawn is two feet from the prism, and the paper one foot, the copy will be half the size of the original; if the object is one foot from the prism and the paper two feet, the copy will be twice the size; and so in proportion for any intermediate distance.

Price, $8.00 to $12.00.

Graphic Mirror.—(Fig. 707, next page.)—An instrument for drawing objects in true perspective, and for copying, reducing, or enlarging other drawings. The upper part of the instrument consists of a triangular box, having a fixed reflecting mirror or looking-glass within it, and a transparent

Fig. 707.

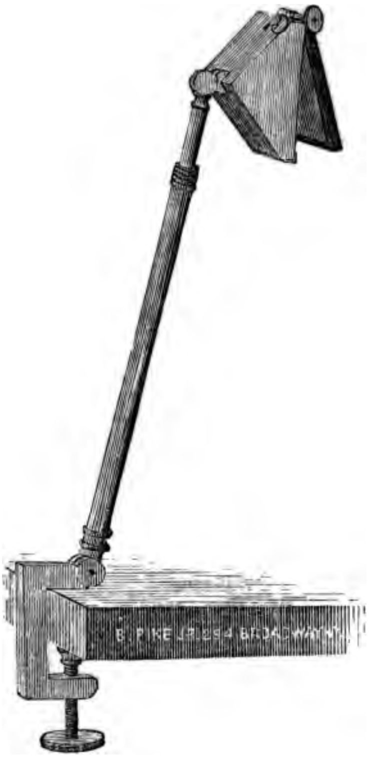

B. PIKE JR. 294 BROADWAY N.Y.

plate of glass in the front, and which is capable of adjustment. The rays from the object pass through the glass to the reflector, and upwards to the eye, which sees them by looking through the small hole at the top. The form or general arrangement of all these instruments is similar, and easily understood from the cut. The management of the instrument is best given in the inventor's own words, especially as they are applicable to all similar contrivances. The instrument being fixed by the clamp and screw to the table and paper on which the drawing is to be made, look through the eye-hole having the front of the case which contains the glasses opposite the object to be copied, adjusting it by means of the joints, and getting the first line perpendicular, the whole of the tracing will prove to be in true perspective.

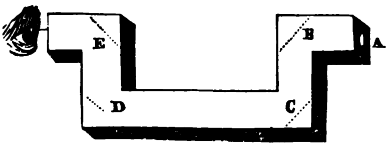
If objects can be seen distinctly on the upper part of the paper, and not on the lower, incline the part of the case reflected downwards by the joints, until the reflected image is on the part of the paper required. Many persons, upon first attempting to use the instrument, occasionally lose sight of their object or pencil by an unintentional motion of the eye; to avoid which, contract the eye-hole by means of the eye-piece which covers it.

The greater the distance from the object, and the higher the case containing the glasses is from the drawing paper, the larger the image will be represented, which is obtained by the sliding tube, and fixed to any point by the tightening screw; on the contrary, the nearer the object and shorter the instrument, the smaller the drawing. The sliding tube is divided for the purpose of ascertaining the height of the instrument, should the drawing not be finished at one time.

Some little attention is necessary to the position for taking profiles, sketching flowers, &c. Darken one half of the window to shade the instrument, and place the object on the opposite part of the table in the light, having the table close to the window; the latter always to the right hand, as in the manner usually adopted by artists when taking likenesses.

The eye-hole should be kept closed when the instrument is not in use. Should the mirror become dull from the damp or dust, remove the bottom by means of the screw. Slide the front glass gently downwards for the purpose of cleaning the mirror. Care being taken, the instrument will be as perfect as ever. Price, $10.00 and $12.00.

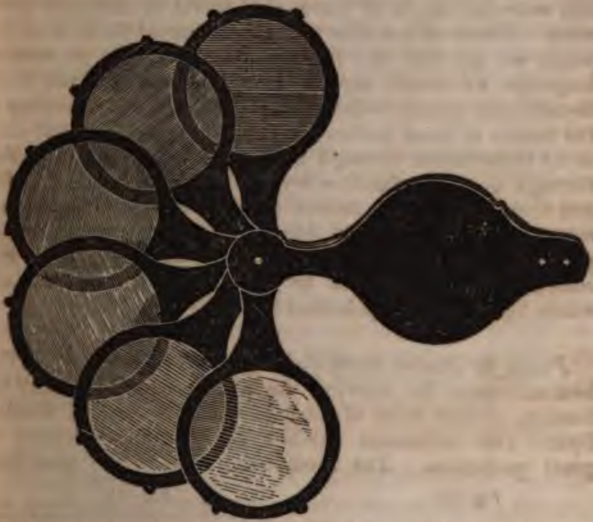
Fig. 708.



Polemoscope.—(Fig. 705.)—A reflective perspective glass, invented by Hevelius, who recommends it as useful in sieges, &c., for discovering what the enemy is doing, while the spectator is hid behind an obstacle. It is, however, more used by lecturers to illustrate the phenomena of reflection. The annexed is a section of the instrument; it consists of a rectangular box, two or three inches square, bent four times at right angles, and containing at those angles four looking-glasses, placed at the angle of 135° with the adjacent sides. Suppose a ray of light to enter at A, it would impinge upon B, and be there reflected to C. At C a second reflection takes place, which passes the light to D. A third reflection carries it to E, and a fourth reflection sends it to the eye. It is evident the instrument will set equally well when a solid is interposed between the one arm or extremity and the other. Price, $5.00.

The Multiplying Glass.—This glass is formed as a plano-convex lens, the convex side of the lens being cut in what the lapidaries term facets, consequently as many flats or facets as are cut in the glass, so many objects will be seen. They are sometimes mounted in a conical case, and by giving it a quick circular motion the objects appear to jump one over the other. Price, $0.50 to $3.00.

Fig. 709.



Claude Lorraine Glass.—(Fig. 709.)—This consists of a variety of different colored glasses, about one inch in diameter, mounted in horn frame and turning on one centre, for producing a great variety of colors and showing their combination; it also will be found both pleasing and useful for viewing eclipses, clouds, landscapes, &c.

Price, $1.50 to $3.00.

Claude Black Glass Mirrors.—Claude's black glass mirrors, for perspective drawing. These are very useful for the young artist, as they condense or diminish the view into the size desired for the intended picture, and all objects bear their relative proportions. Price, $2.50.

Apparatus for the Polarization of Light.—The phenomena produced by the polarization of light are among the most splendid and singular in the whole range of physical science. Common light consists of undulations, in which the vibrations of each particle are in the plane perpendicular to the wave's motion. The polarization of light is the resolution of each vibration into two; one parallel to a given plane passing through the direction of the wave's motion, and the other perpendicular to that plane, which become in certain cases the origin of waves that travel in different directions. When we are able to separate one of these from the other, we say that the light is polarized. Or, in simpler language, we would say, when the light of the sun is reflected from certain bodies at particular angles, according to the nature of those bodies (as glass at an angle of 56° 45′), or by transmission through a plate of tourmaline, and also through doubly refractive crystals (as carbonate of lime), and these bodies are turned round, the light becomes in a measure decomposed, one side of the ray presenting an appearance and properties different from the other; these two contrary sides are said to be the poles of the ray, and the whole light becomes polarized light.

Prism for Double Refraction.—(Figs. 710 and 711.)—The best substance for showing the phenomenon of double refraction, is that form of carbonate of lime, called Iceland Spar. This substance exhibits the double refraction in great perfection. The rhomboidal form is the most convenient. Let a black line be drawn on a piece of paper, and let a rhomb of this spar be laid upon it; then, on look-*through* the upper face of the spar, down on the paper, two *lines* will be seen, and any object viewed at a distance

Fig. 710.

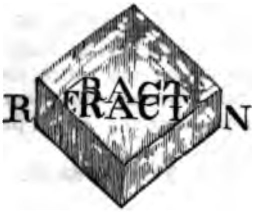
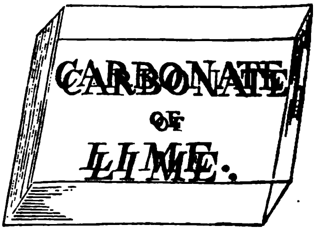


Fig. 711.



through the spar will appear double, and the images will be more separated from each other as the distance of the object increases; if the rhomb be turned about so as to complete a revolution, the two images will have a regular motion, so that one will fall twice on the prolongation of the other.

Fig. 711 is a drawing of a model representing a rhomb, with a ray of ordinary light incident upon one of its natural faces, and which, in passing through the crystal, is divided into two rays, one of which is refracted according to the ordinary way; the other, not obeying the same law, but being refracted in an extraordinary manner, is called the extraordinary ray. Price, $2.50, $4.00, and $5.00.

Nichol's Prism.—Nichol's prism, or Nichol's eye-piece, (Fig. 724, page 199), is a most valuable and convenient polarizer. It is an oblique rhombic prism, whose terminal planes form an angle of 68° with the adjoining obtuse lateral edges. It is formed by joining two wedge-shaped pieces of Iceland spar. It is a double refractor, but the two rays are made to deviate so far that only one image is seen in its usual position. Over the tourmaline this prism has the advantage of being perfectly free from color, but gives a much more limited field of vision. It is usually mounted in a brass cell with tube to hold by when rotated on its axis.

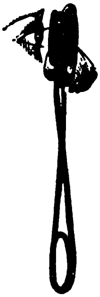
Price, $5.00.

Tourmaline Plates.—The tourmaline is the most remarkable among the crystallized minerals for possessing the property of polarizing light transmitted through them; for this purpose the crystal is cut parallel to its axis, into thin plates of a uniform thickness (about $\frac{1}{30}$ of an inch) polished on each side, and fixed between two plates of glass for preservation, when it will possess this property in a remarkable manner. Now, if we hold such a plate before the eye, and look at the light of the sun, or the flame of a candle, a great portion will be transmitted through the plate, which will appear transparent, having only the color of the crystal, which in specimens suited for these experiments is generally brown or green; but the light so transmitted will be polarized light, and being analysed by a second plate—which may be done by looking through both at the same time—

we shall find that when the axes of both plates coincide, or are parallel to each other, the light which has passed through the first will also pass freely through the second, and they will together appear perfectly transparent; but when one is turned round, so that the axes of each plate are at right angles, or across each other, not a ray of light will pass through; they will appear perfectly opaque, although we may be looking at the meridian sun. On viewing pieces of selenite or mica through one of these plates in polarized light, they will be seen having the most beautiful colors, which will change by the turning of the plate.

Price, $2.50, $4.00, and $6.00.

Fig. 712.



Tourmaline Polariscope. — (Fig. 712.) — Two plates of tourmaline are mounted in cells capable of being rotated on their axes, and supported before each other by a spring frame, between which crystals may be conveniently supported, and the system of beautiful rings observed, represented in Fig. 713, 714, 715, and 716.

Price, $4.00 and $5.00.

Fig. 713.

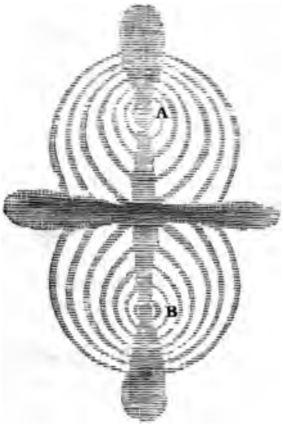


Fig. 714.

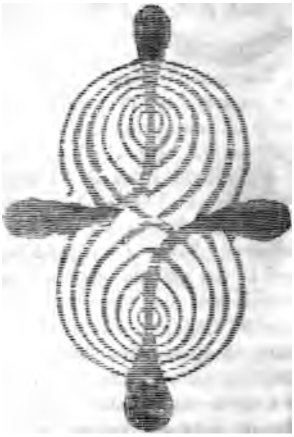


Fig. 715.

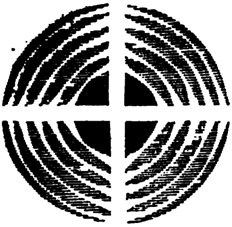
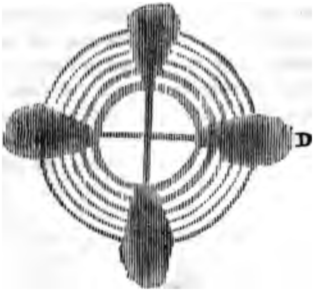


Fig. 716.



Selenite Designs.—Numerous splendid and beautiful effects are produced by arranging plates of selenite of different thicknesses and designs, on plates of glass. These, in ordinary light, will appear perfectly transparent; but when viewed in polarized light, will exhibit the most gorgeous coloring, and may be made to undergo the most extraordinary changes, by viewing them through a tourmaline plate, Nichol's prism, or any other analyzer, and causing the analyser to revolve before the eye. They are mounted between circular glass plates, one and three quarter

Fig. 717.

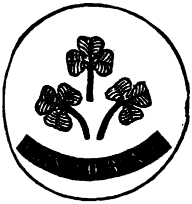


Fig. 718.

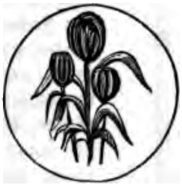


Fig. 719.

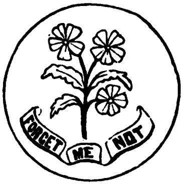


Fig. 720.

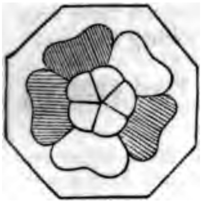


Fig. 721.

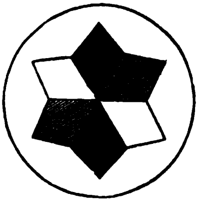
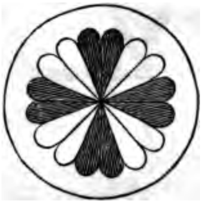


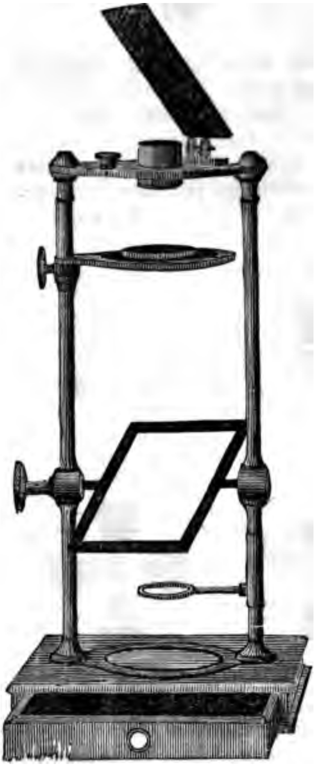
Fig. 722.



inches in diameter, set in polished mahogany frames, and are represented in the polariscope, Fig. 712; some of the designs represent five and six pointed stars, rosettes, tulips, thistle, the flower forget-me-not, and a variety of others, some having mottoes. A few representations are given in Figs. 717 to 722; but to form any idea of their beauty they must be seen in their beautiful coloring.

Price, $2.50, $3.00, and $4.00, each.

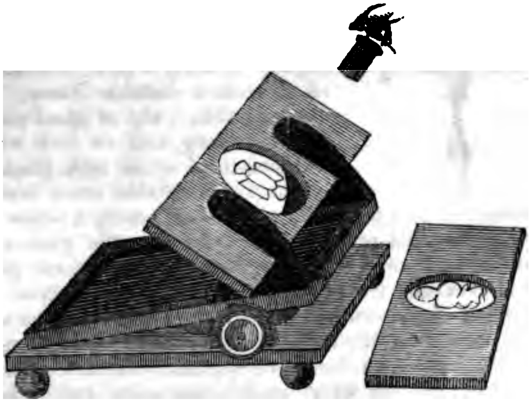
Fig. 723.



Biot's Reflecting Polariscope.—(Fig. 723.) — Biot's reflecting polariscope, as represented in the cut, having polarizing and analysing plates with horizontal movement, and graduated circle; movable stage for crystalline plates, tourmaline cell, double image or Nichol's prism, plane mirror, and condensing lens. The framework of highly finished brass mounted on a mahogany base, with drawer for holding the smaller parts.

Price, $12.00.

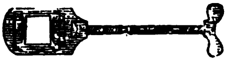
Fig. 724.



Polariscope with Selenite Designs.—(Fig. 724, next page.) —This polariscope with selenite designs, consists of a black glass mirror for a polarizer, which is mounted in a frame movable on an axis, with screws to tighten, and having a frame over the mirror to support the slide containing the selenite designs, six of which accompany the instrument. They are viewed through a Nichol's prism set in a cell rotating in a tube to be held by the fingers. The forms of some of these beautiful designs are represented in Figs. 717 to 722. The tints are of the most gorgeous description, presenting every variety of color and shade.

Price, $25.00.

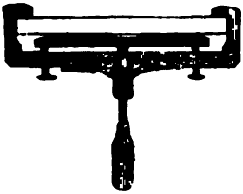
Fig. 725.



Double Refraction communicated to Plates of Glass by Mechanical Force. —(Fig. 725.)—This apparatus for showing the transient polarizing structure communicated to a piece of annealed glass by pressure, consists of a plate of glass well annealed, from one to two inches square, and about one-third of an inch in thickness, contained in a brass frame between two rounded pieces of steel, having a screw by which any required pressure may be given to the glass; the polarizing structure is to be viewed by means of a tourmaline, or Nichol's prism, when the system of fringes appear with their colors.

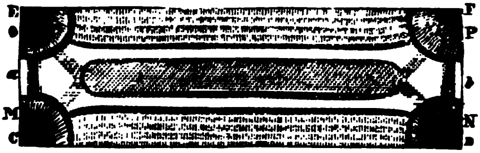
Price, $5.50.

Fig. 726



Polarization by bending a Glass Tube.—(Figs. 726 and 727.)—Analagous effects are produced by slightly bending a piece of annealed glass in a suitable frame. To illustrate this, a slip of glass about six inches long, half an inch wide, and one-third of an inch thick, is confined in a suitable brass frame, and pressed at two points by a steel bar, having a screw by which any required pressure may be given; the glass may thus be unequally and differently strained; the minute parts on the convex side are urged asunder and their attractive forces called into operation, while those on the concave surface are pressed together, and their repulsive forces brought into action. Between these two oppositely affected surfaces there is a neutral line where equilibrium exists, and on both sides of this the degree of strain augments as we recede from the line. Now, if the slip of glass be examined while in the polariscope, it will be found to have acquired while in the bent state, double refracting properties. Two sets of colored fringes are perceived, one on the convex or dilated side of the plate, and the other on the concave or compressed side. Between these two sets of fringes is a black line, indicating the situation where neither compression nor dilation exists, and where, therefore, double refraction is absent.

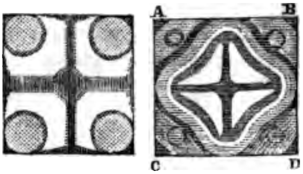
Fig 727.



Price, $5.50.

Double Refraction by unequal Heating.—To illustrate this, a plate of glass, about 1 inch square, and $\frac{1}{3}$ of an inch thick, is fitted into a brass frame, having a rod and handle. The frame is heated, and the plate of glass placed therein. Glass being a bad conductor of caloric, and when a heated body is applied to it, the part in contact with this becoming hot, expands, but owing to the bad conducting quality of the

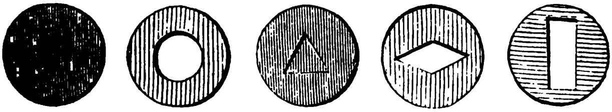
Fig. 728.



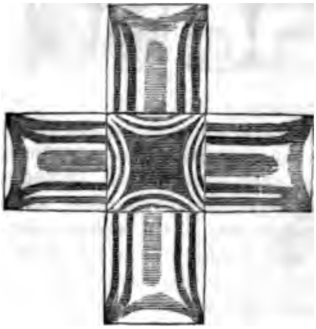
medium, the surrounding parts, not being influenced by the heat, do not expand, but resist the dilation of the heated portion. In this way, therefore, the immediate effect of heat on one part of a piece of glass (Fig. 728) is to put all the surrounding parts into a strained state; one part is expanding, and the other parts are resisting the dilation. It is obvious, then, from the unequal states of tension of the different parts of a piece of glass thus partially heated, that it ought to acquire doubly refracting properties; and the polariscope shows that it does so. In this state, the glass exhibits distinct neutral and doubly refracting axes. Unequal cooling will also cause the plate of glass to acquire doubly refracting properties, and when examined by polarized light, presents fringes, &c., similar to those observed in glass unequally heated. Price, $2.00.

Unannealed Glass a Double Refractor.—On considering the mechanical condition of unannealed glass, it is obvious that the different parts are unequally and differently strained; the internal being in a state of distension, the external in that of compression. So that the state of the different parts and the distribution of the forces will be exactly similar to those described in annealed glass, occasioned by unequal heating. One very important point in reference to these unannealed glasses is that the polarizing structure depends entirely on the external form of the glass plate, and on the mode of the aggregation of its particles. This will be very obvious by observing the different shapes of the fringes respectively presented by square, circular, oval, triangular, rectangular, and other shaped plates (Fig. 729). The circular and square plates have only one axis, whereas the oval and rectangular have two axes. These unannealed glasses are of a *variety* of shapes, and are usually about one

Fig. 729.

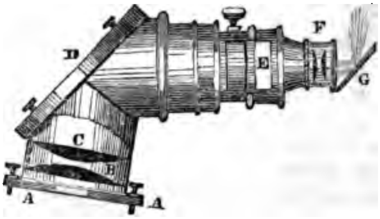


inch across, and mounted generally in cork frames for convenient handling and preservation, and beautifully illustrate the dependence of the form of the colored fringes on the external shape of the glass. Price, set of five, $8.00.
" " ten, $15.00.



If two unannealed rectangular pieces of glass are crossed at right angles the structure of the fringes will be varied in a similar manner to those represented in the drawing annexed.
Price, $2.50.

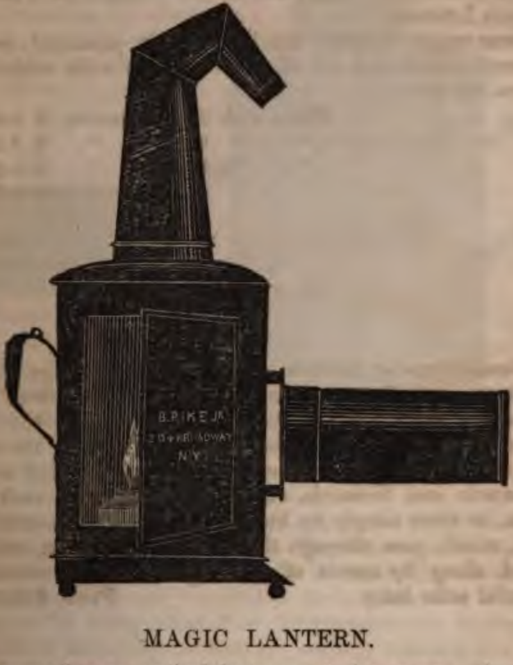
Fig. 730.



Oxy-Hydro Polariscope.—(Fig. 730.)—This is an apparatus to show the phenomena of polarization of light to a number of persons at once. The name implies that the light decomposed is produced by the united effect of burning the two gases named. The burning gas is thrown upon lime, exactly as shown under oxy-hydro microscope. The polarizing apparatus is in principle what has been already described, but having magnifying lenses attached, it is capable of being thrown upon an extended screen at a distance. Suppose A A to be screwed on to the front of a magic lantern, or oxy-hydrogen microscope box, instead of the usual nozzle—the light would pass through the two lenses, B and C, and be reflected from and polarized at D, which is a bundle of glass plates. Passing along the tube, it is again reflected at G; another bundle of glass plates, previously, however, passing through the lenses under F. Finally it is thrown on to a screen from G. Into the hole, E, is placed the film of crystal, from which the colors are to be thrown.

MAGIC LANTERNS.

Fig. 731.



MAGIC LANTERN.

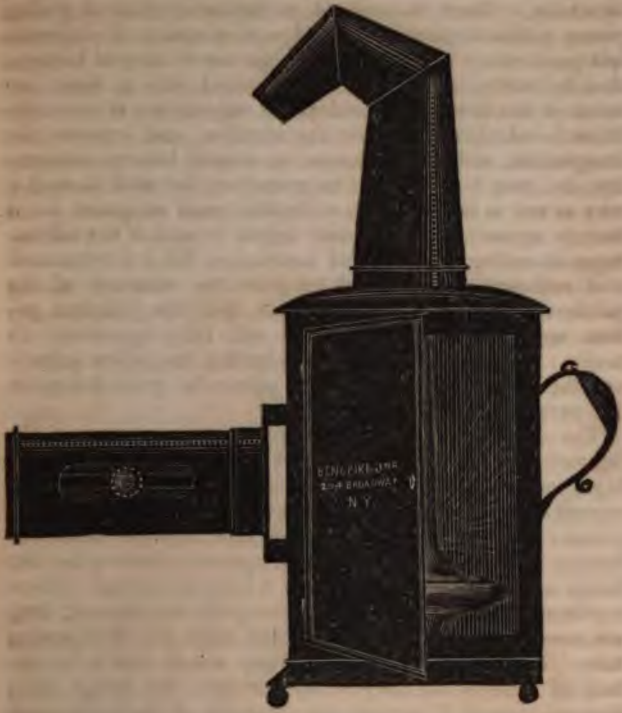
A WELL known optical instrument, by means of which small painted figures on the wall of a dark room are magnified at pleasure. The above cut (Fig. 731) represents the common instrument:—A small lamp, with a reflector behind it, is placed in a tin lantern, to the front of which is a *projecting* tube open on both sides; at the side of which tube, and near that end which is nearest the light, is a hole, to move the sliders in and out. A second tube slides withinside the first. The requisite lenses are a thick plano-convex lens at that end of the tube which is fastened to the lantern; and a double convex lens at the outer end of the smaller tube. The slider of objects is placed in the square hole prepared for it; the light passes the plano-convex lens, strikes the picture, and passes to the smaller lens, whence it is cast on the white wall of an apartment, or a sheet, or other screen. A better way of glassing the lantern is described under the article "Improved Phantasmagoria Lantern."

These magic lanterns are handsomely japanned, having oil lamp, reflector, a set of twelve sliders with mahogany frames and box.

Price,	with	2	inch	lenses,	$ 5.50.
"	"	2½	"	"	$ 8.00.
"	"	3½	"	"	$10.50.
"	"	4	"	"	$16.00.

Phantasmagoria Lantern.—(Fig. 732, next page.)—The phantasmagoria lantern differs in no degree whatever from the above, except the lenses being larger and the tube holding them is made so as to project beyond the outer lens, and the lens itself is made to slide readily and evenly backwards and forwards, either by means of a rack and pinion, or more simply by little studs, fastened on each side of it, which pass through the sides of the tubes, and are moved along by means of the finger. It also contains a powerful solar lamp. Price, $15.00.

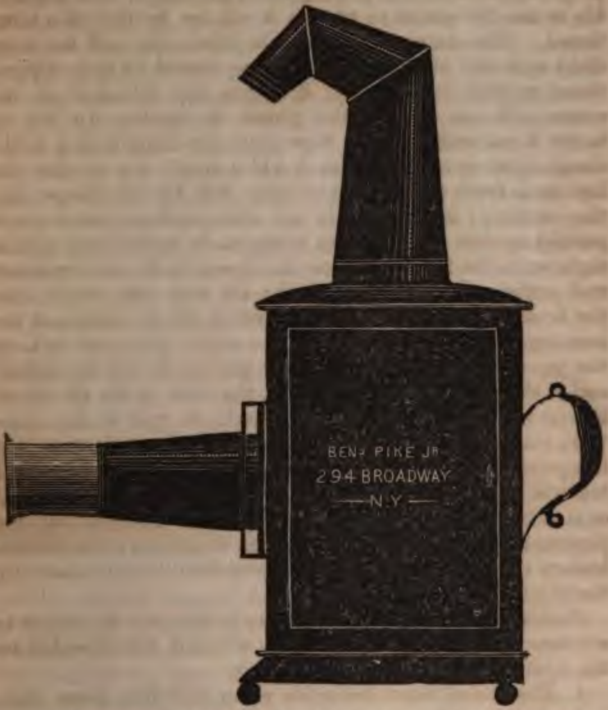
Fig. 732.



Improved Phantasmagoria Lantern, with a Solar Lamp.—The magic lantern, which was formerly used merely to amuse children, by the exhibition of miserable caricatures and grotesque figures, has of late years assumed a different character, by being adapted to the representation of subjects of natural and scripture history, botany, astronomical diagrams, the costume of different countries, &c. With the view of rendering the magic-lantern a source of highly instructive amusement as well as entertainment, the writer has produced, at a considerable expense, a variety of sliders of a very superior order. With these sliders the phantasmagoria lantern *will become* not only a most amusing and ratinual recreation, but a powerful auxiliary in the work of education. There is, perhaps, no better method of giving young people a greater knowledge of a variety of subjects, and particularly of the different branches of natural history, than by well colored plates, accompanied with a short account of the subject. .Besides, the very nature of the exhibition is calculated to excite the attention, and impress the imagination, and many a lesson in natural history, astronomy, &c., may be given and impressed on the mind in such a way as not to be forgotten, while the pupil supposes he is merely amused. A great deal might be said of the advantages attending this mode of instruction, but it is presumed that sufficient has been said to draw the attention of the public to it; and there is no doubt, that the judicious parent and enlightened instructor will fully appreciate its merits ; indeed, its extensive introduction into infant schools and the lecture room, sufficiently proves its great utility for the purposes of education.

The cut (Fig. 733, following page) represents one of the improved phantasmagoria lanterns; a tin box fifteen inches high, ten long, and seven and a half wide, having two double convex lenses mounted in a brass cell, and kept in by a counter screw and slip into a short tube soldered inside the lantern ; the painting is slid in an aperture close to the two lenses and is kept in its place by a heliacal spring. There are two double convex lenses to magnify the picture; they are screwed into a brass tube, which slides in a short spring tube. The other end is contracted by a stop, which, by cutting off some of the extreme rays, renders the image more distinct, though it lessens the quantity of light; in some subjects the light may be thought of the most importance, and the stop is therefore made to unscrew. This lantern has met with the approbation of the most eminent opticians, as well as every other person who has either examined the principle on which it is constructed, or witnessed its effect. The addition of a solar lamp renders the images much more brilliant and distinct, and of course they can be more magnified. The lamp is of a very simple construction, and can never be out of order, and can be easily emptied ; a great advantage for this particular purpose. The lantern is constructed so that the lamp receives a plentiful supply of air from without, and not from the inside of the lantern, as is *generally* the case, the consequence of which is, if the lamp

Fig. 733.



burns brilliantly and without smoke when out of the lantern, it is sure to do so when in it; the improved phantasmagoria lantern possesses a great superiority over those generally made of equal power. Price, with 3 inch lenses, $14.00.
" " 3½ " " $15.00.
" " 4 " " $18.00.

To use the Phantasmagoria Lantern.—Trim the lamp with the finest spermaceti oil, and make it burn brilliantly; take care it does not make the least smoke, to prevent which, it is necessary that the top of the cotton should be kept perfectly even, which is made so in a very simple manner, by putting the cotton upon the bucket, then winding it down into its place, and burning off the cotton that projects, previously to putting oil in the lamp; it is impossible to cut the cotton so true as it will be by the plan mentioned. The cotton should now be taken out, and the lamp filled with oil; the top of the cotton should be then dipped about an inch into the oil; if this is not attended to, the cotton will not possess the power of drawing up the oil to the flame sufficiently. Now place the lantern on a table, about eight or ten feet from a white wall; the further the lantern is from the wall, the larger will be the image, and the contrary; if the wall is not white, a sheet may be suspended against it; the room being made as dark as possible, sit down to the table with your face towards the wall or sheet, and putting a slider through the slit with one hand, slide the brass tube in or out with the other, till the image of the painting is perfectly distinct on the wall; take care to keep the painting in the centre, or only part of it will be visible, and it should also be kept against that side of the slit which is next the light. Every slider should be put in the same way, viz. with the right or lettered side towards you, and the paintings inverted. Instead of placing the lantern on a table, it is often more convenient to hold it under the arm, or it may be fastened round the waist, as directed for the phantasmagoria, taking care to keep it upright; the natural history subjects may then be given in their natural sizes with the utmost facility.

Besides the foregoing directions it may not be amiss to mention the following particulars, which if not attended to, the figures will be dull and indistinct.

1. The lenses must be quite clean and free from dust, and what is still worse, damp. If any appears between them, the glasses should be separated, and well wiped with a piece of wash-leather, or a clean dry linen cloth. If the lantern has stood for some time it will be always necessary to do this previously to exhibiting it.

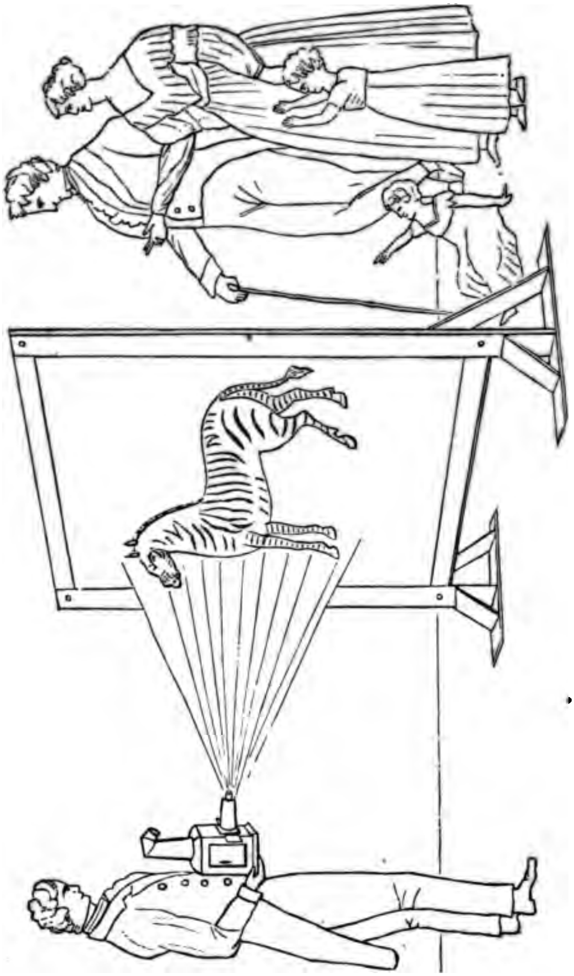
2. The glass of the sliders should never be soiled with the fingers, and if dusty must be well wiped, taking particular care to go over the painted side very gently.

3. The lamp must be made to burn brilliantly, and the lantern should not be used till that is found to be the case. It is much better to trim the lamp every time an exhibition is made, and never to use the lamp or cotton if they have stood with oil any length of time; it is recommended that *the lamp* be always cleaned before putting away.

Directions for exhibiting the Phantasmagoria.—(Fig. 734.)—For this purpose, instead of the image being exhibited on a white wall or sheet, it is thrown on a transparent screen placed between the spectators and the lantern. The screen not being seen, the image appears to be suspended in the air, and when the image is increased or diminished, it appears to the spectators to approach or recede from them. The deception is so complete, that even those who are accustomed to the exhibition, and know where the screen is placed, are deceived by it. For the production of this very amusing and striking exhibition, no additional apparatus is necessary, except a transparent screen. This has usually been made of silk or muslin, either varnished or coated with a mixture of turpentine and beeswax. These screens are not only expensive, but very soon get injured and dirtied. The following is a very simple method of making an excellent one; instead of varnishing the muslin, it is only dipped in water, and hung up quite wet. A screen of this kind costs but a trifle, can be folded up in small compass, and when soiled is easily made clean; so far from having any disadvantage to counterbalance these advantages, it is superior in effect to any other, and has this peculiar and great convenience, that it requires no stretching, and hangs more level than any other. The muslin it is made of should be of the closest texture, and need not be very fine. The screen should be hung on a frame, and being wet will require no fastening; the frame itself may be made so as to take to pieces and tie up together in a small compass. The screen being prepared, should be so placed in the room as to leave space enough for the spectators, without their being too near it. If there is a door between two rooms, the screen may be suspended from the door frame; this is a very convenient method.

The person who manages the lantern must fasten it to his middle with a leather strap passed through the loop, soldered to the back of the lantern, and holding the lantern with one hand, adjust the tube with the other; he should now go up pretty close to the screen, and draw out the tube till the image is perfect; which of course will be very small; then walking slowly backward, and sliding the tube in at the same time to keep the image distinct; as it increases in size, it will appear to the spectators on the other side the screen to be coming towards them, and then again by walk-

Fig. 734.



ing towards the screen to diminish the image, it will appear to them as if it was receding.

The only difficulty in making this exhibition, is in sliding the tube in or out properly to keep the image perfect: no rule can be given that would be of any service, but the operator will soon perceive that when the image is got to a moderate size, the tube requires to be slid in very little to increase it; but when the image is about four or five inches diameter, to reduce it to one half that size, the tube will require to be drawn out more rapidly: practice alone will enable him gradually to reduce or enlarge the image, and at the same time to keep it distinct.

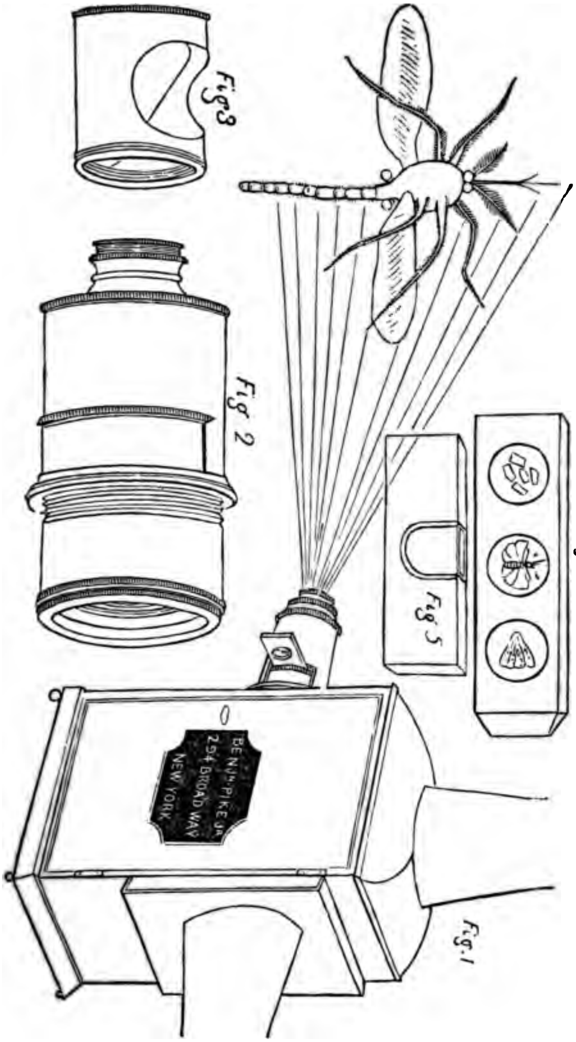
To give Motion to the Images.—A variety of movable sliders are made for this purpose, many of which produce very curious appearances, but with the usual sliders the images may be made to move in a circular, elliptical, or other direction, by moving the lantern in the corresponding way, which will of course produce the like motion in the images. A curious effect is also produced by drawing out the tube and slipping it in suddenly to the focus; this is easily done by holding the tube tight at the proper place. A shivering motion may be given to the images by giving the lantern a sudden shake. By standing at the bottom of a pair of stairs, a figure may be made to appear going up, by giving the lantern a slight angular motion; the figure of the skeleton is a very good one for this purpose: in the same way this figure may be made to lie on the floor and rise up to a sitting or standing posture. By combining the motion of the lantern with movable sliders, a great variety of curious effects may be produced, particularly on the transparent screen; many of these are often exhibited in public, and from what has been said, those who take pleasure in this machine, will soon be able to produce most of them.

Description of Carpenter's Improved Lucernal Microscope.—This microscope is used to exhibit transparent objects on a screen or white wall, in the manner of the solar microscope; though from the difference in the intensity of the solar light and that from a lamp, the effects are very inferior. The lucernal microscope has, however, some advantage over the solar; it can be used by night, and in the long evenings, when amusements are most necessary; it is more simple in its construction, and easier to manage; and even when combined with the improved phantasmagoria lantern, is less expensive than the commonest solar microscope. Objects may be magnified by this microscope from a few inches to eight or nine feet diameter, or even more, but most objects appear best when magnified from three to six feet. The screen, if there is no white wall, should be made of large drawing-paper, strained tight on a frame. The screen used for the phantasmagoria, or a window blind, will answer, but not so well as one made of paper, many of the finer parts being rendered indistinct by the irregularities of the surface, and also from much of the light passing through the screen instead of being reflected from it. By the addition of a plane mirror, fig. 3, plate 735, set in a brass frame, which screws on the magnifier tube, objects may be thrown on a sheet of paper placed either on the floor or on the table, or they may be reflected up to the ceiling.

To use the Lucernal Microscope.—(Fig. 735.)—It is represented in the plate attached to the improved phantasmagoria lantern, in which way it is generally made, though it may be constructed to act as a microscope only. Unscrew the brass plate which fills up the hole in the back part of the lantern, and screw the microscope, fig. 2, in its place; see fig. 1. Having made the lamp burn brilliantly, and the lantern being placed on a table about four or five feet from, and directly opposite the screen, push in one of the sliders with objects, fig. 4, between the spring plates, and adjust the magnifiers to the focus, by turning round the tube in which they are fixed.

It is hardly necessary to remind the operator that the lenses should be perfectly clean, and the room as dark as possible, as upon these circumstances in a great measure depends the perfection of the image. If you wish to make a drawing of the image, place the lantern on a high stool upon the table, and screw the frame, fig. 3, into the front part of the microscope, by turning it round so that the mirror be below; the image will be represented in a very beautiful manner on a sheet of paper placed on the table to receive it, and an accurate outline may be taken of it, even by those unaccustomed to the use of the pencil. By bringing the tube of the microscope beyond the edge of the table, the image may be reflected on the floor, and by turning it

Fig. 735.

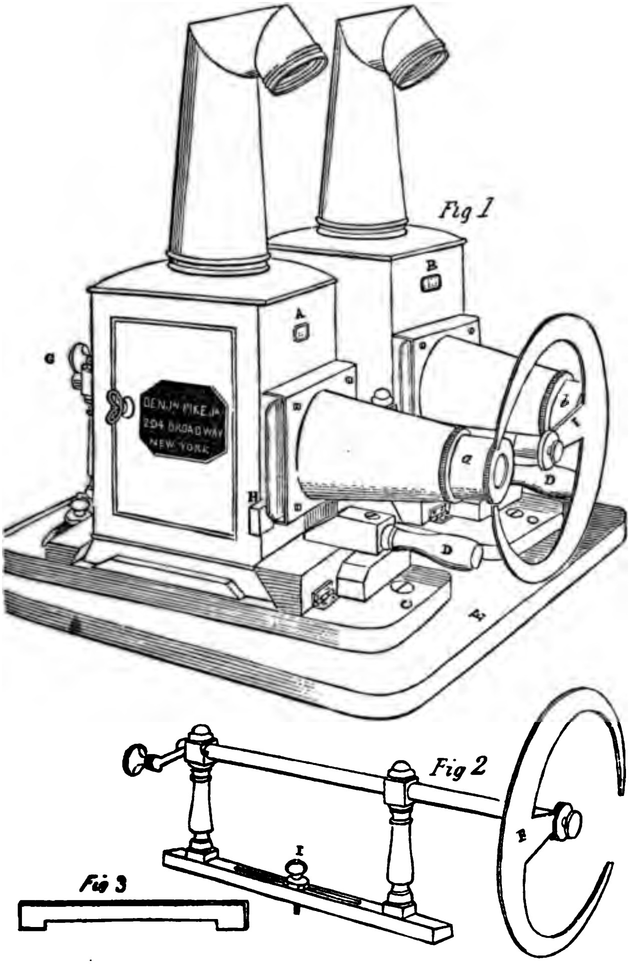


upwards the image is represented on the ceiling. The image may be made of different sizes by removing the lantern further from, or nearer to the screen; for in proportion as the distance is increased the image is enlarged, but at the same time becomes fainter. When the microscope is used the tin cap should be pushed over the large lenses of the lantern, to prevent the light from escaping.

The following is a list of the objects best adapted to this microscope:—Cuttings of woods and herbaceous plants, particularly such as have large pores; wings of insects; scales of fish; the cast skins of spiders and other insects, snakes, lizards, &c.; feathers, particularly those of the open kind; dissected leaves; corallines, called sea moss; marine fuci, or sea weeds; small living insects, such as aphides or plant lice, cheese mites, small flies of various kinds, the common bug, &c., &c.; some kinds of seeds, as carrot, thistle, cyanthus minor, &c. Many artificial objects have a good effect, such as cambric, worked muslin, gauze ribbons of different patterns, sewing silk and cotton, pins and needles, &c. Any of the above may be inclosed between the glass of the spare slider. The water furnishes a great number of various objects, admirably adapted to the lucernal microscope; they must be exhibited in the water slide, fig. 5.

The Dissolving Views.—The exhibition of the dissolving views is one of the most extraordinary and magical effects that the lantern is capable of producing. No term can better express these wonderful changes than "dissolving;" for while the spectator is viewing a painting, it is made most imperceptibly to *melt* into quite a dissimilar picture, *e. g.* a painting representing the *exterior* of an Abbey being under view, this is insensibly changed into the *interior* of the same building, without the observer being able to detect any apparent alteration, until the new picture appears to grow perfectly distinct before him; hence he is led to suppose the change to have taken place upon the *same* painting,—whereas another view has been substituted, without leaving the screen in darkness for an instant. A great convenience connected with this exhibition is, that it may readily be exhibited in an ordinary sitting room, and if the room should be furnished with folding doors, the effect is much increased, as the exhibitor may be placed in one room, while the spectators are in the other.

Fig. 736.



The mode of producing this pleasing and fascinating illusion **is by the** employment of two lanterns, as shown in **the above cut, fig.** 1, where the whole apparatus is arranged **and set up** ***for use.*** *It is* important that each lantern be of the same size and power. The lanterns, A, B, should be placed side by side on two slabs of wood, C, C; these pieces of wood turn upon a screw, and are firmly fixed in their places by the thumb screw behind the lantern. The slabs, C, C, are screwed upon a larger piece of wood, E, about two feet square, so that they may be inclined to such an angle, that the circle of light from the two lanterns may exactly coincide upon the screen, as though the light was proceeding from one instrument. It is also of much consequence that the paintings are placed in the centre of the lenses, this is easily accomplished by means of the mahogany guide, fig. 3, which is shown in its position at H, fig. 1.

The lamps having been made to burn brilliantly and put into their places, incline each instrument until the light falls exactly upon the same spot upon the screen; then give the thumb screw a turn, which will retain the lanterns at the angle required. It will be seen that the lanterns are kept down upon the slabs by means of the handles, D D. A painting is now to be introduced, and the focus adjusted by means of the tubes, *a b*; the crescent formed shade, F, is then to be drawn pretty close to the pipes, and secured by the thumb screw, I, fig. 2, the object being to cover and uncover each aperture alternately. It will be evident that as the shade is caused to make its half revolution, by turning the handle, it follows that the moment the shade begins to cover A, a corresponding part is exposed of the painting in B, and the more slowly this shade is made to revolve, the more gradual will be the change; the picture in A imperceptibly melting into the one in B. There is a pin in the rod which turns the shade, F, so that it can only be made to move the half revolution. To make a change, remove the painting in A, and replace it by another, then gently reversing the operation.

The guide, fig. 3, will be found of essential service; it is made to fit tightly the opening of the lantern which receives the sliders; this guide is exactly the length of the sliders, and is so fitted, that when the sliders are pressed down upon it, and the ends of the sliders correspond with the ends of the guide, the exhibitor is sure that his painting is in its central position; it is of course supposed that each picture is in a separate slider, and that the paintings are in the centres of the sliders.

ic *Lantern Sliders.*—These consist of transparent gs on glass, having all the variety of coloring in the object, and illustrating a great variety of grotesque mic scenes, landscapes, views, portraits, some of are double slides giving motion to passengers, vessels, f the body, &c., &c. Also extensively used in illus- the sciences of astronomy, botany, natural history, r exhibiting the costumes of the different nations, cenes from Scripture history, views in the Holy Land, variety of others too numerous to mention. The ed slider is four inches wide, and where several views the same slide, about sixteen inches long; each slide sed in a mahogany frame, or the separate paintings rted in circular openings in the frame, according to cription of slider: these slides are the proper size phantasmagoria lantern. Besides which there is a of smaller sizes called 12 inch, 10 inch, and 8 inch suitable for smaller instruments.

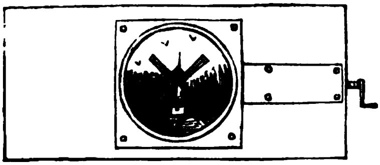
Fig. 737.

Movable Sliders.—(Fig. 737.)—This slider represents a barber, shaving. By drawing the loose slide, motion is given to the arm and razor, the motions being represented on the screen almost as natural as life. There are also me hundred different changes and representations in e style.

Price,	large size,	4 in. wide,	each	$1.25.
"	second "	3 in.	"	$0.83.

r *Sliders*, representing various movements, as a horse, wan bending his neck to drink, man bowing, ship roll- the sea, and numerous others. Price, each, $2.50.

Fig. 738.



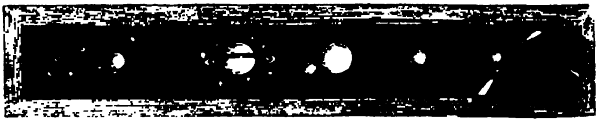
Sliders—(Fig. 738)—Representing various move- as the *turning* of a wind-mill, &c. Price, each, $3.50.

Fig. 739.

French Movable Sliders—(Fig. 739)—Representing comic, grotesque, and ludicrous views, the movements set in brass mounting. Price, each, $2.00.

Astronomical Sliders.—(Fig. 740.)—These are most usually in sets, embracing eleven sliders, three of which are movable; one representing the rotundity of the earth; one the eclipse of the sun, with the transit of Venus; and the other the eclipse of the moon. There are thirty-two views in this set, embracing the most important diagrams, with book, describing each slider in the form of an astronomical lecture.

Fig. 740.



Price of large size, in case,		$20.00.
" 12-inch long,	-	$15.00.
" 8-inch "	-	$7.50.

Movable Astronomical Diagrams.—The motions produced by rack-work in a set of nine sliders.

Slider 1. The solar system, showing the revolution of all the planets, with the satellites, round the sun. Price, $5.75.

Slider 2. The earth's annual motion round the sun, showing the parallelism of its axis, thus producing the seasons. Price, $5.00.

Slider 3. This diagram illustrates the cause of spring and neap tides, and shows the moon's phases, during its revolution. Price, $4.25.

Slider 4. This diagram illustrates the apparent direct and retrograde motion of Venus or Mercury, and also its stationary appearance. Price, $4.00.

5. A diagram to prove the earth's rotundity, by a ing round the globe, and a line drawn from the eye server placed on an eminence. Price, $3.75.

6. This diagram illustrates the eccentric revolution iet round the sun, and shows the appearance of its fferent points of its orbit. Price, $5.25.

7. The diurnal motion of the earth, showing the id setting of the sun, illustrating the cause of day it, by the earth's rotation upon its axis.
Price, $4.00.

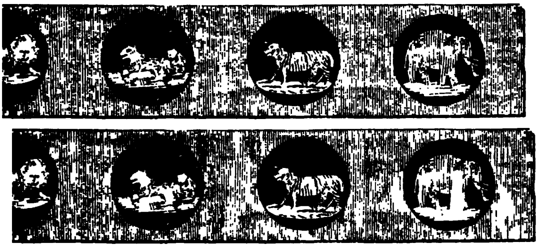
8. This diagram illustrates the annual motion of 1 round the sun, with the monthly lunations of the
Price, $5.75.

9. This diagram shows the various eclipses of the the transit of Venus; the sun appears as seen a telescope. Price, $4.00.

e whole set in a box with a lock, - $38.00.

constellations in six sliders, or twenty-four views; twelve being the constellations of the zodiac, the he most prominent in the heavens.
Price, $12.00.

Figs. 741 and 742.



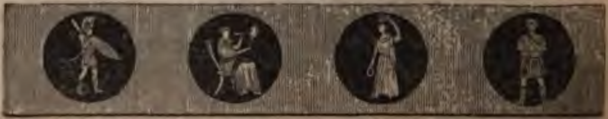
al History Sliders.—(Figs. 741 and 742.)—The al set consists of twelve sliders, having five views slider, or sixty views in all; of which twenty-five als, fifteen birds, fifteen fishes, and five reptiles.

Price, of large size, in case, $20.00.
" 12 in set, " " $12.00.
" 8 in set, " " $ 5.00.

e extensive set of natural history in fifty-six sliders ; *ur of which* are mammalia, seven birds, four amphibia, five fish, eight insects, eight vermes; with book of description. The whole packed in a box.

Price, of the full set, - - - $100.00.
" of the different parts, each slider, $2.00.

Fig. 743.



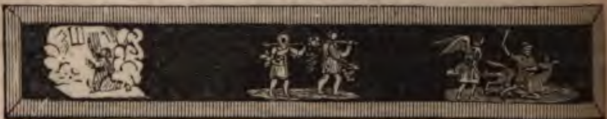
Sliders representing the Costumes of Nations.—(Fig. 743.)—This set consists of twelve sliders, each having four views, or forty-eight in all; showing the present costume of the different nations, representing the male and female figure, and sometimes the children, and with some of the national characteristics. Price, of large size set, in box, $20.00.

A more extensive set of costumes of nations, consisting of fifty-six sliders, and above 290 figures; of which four sliders are of England, three of France, five of Austria, one of Iceland, four of Russia, Greenland, and Lapland, three of Turkey, four of Tartary and Circassia, four of China, three of Persia and Arabia, three of the Empire of Caubul, one of the Birman Empire, five of Hindustan, two of Greece, three of Java and Asiatic Islands, three of Egypt and Abyssinia, four of Tripoli and North Africa, and four South Sea Islands; with printed descriptions. Price, $100.00.

Ancient costumes of the Egyptians, Greeks, and Romans, in six sliders containing twenty-nine figures.

Price, $12.00.

Fig. 744.



Scripture History Sliders.—(Fig. 744.)—Sets of scripture history sliders, illustrating the principal scenes in the Old and New Testaments, in fourteen sliders, or fifty views, two of which are movable, viz. the family of Noah, entering the k with the numerous animals, and the Israelites crossing e Red Sea and destruction of the Egyptians.

Price, of the set, in a box, - -	$36.00.
" sets of twelve sliders, without the movable sliders, at	$24.00 and $32.00.
" movable sliders, singly, each,	$3.25.

Fig. 745.

Botanical Sliders.—(Fig. 745.)—These consist of a set of fourteen sliders, or fifty views, showing the various parts of plants, organs, elementary issues, roots, leafs, stems, structure of wood, with a variety of views of plants, many of the views containing several figures. Price, in a box, $32.00.

Set of twelve sliders, or forty-eight views, representing the most admired flowers.

Price, in a box,	$20.00.
" 12-inch,	$13.00.
" 8-inch,	$5.00.

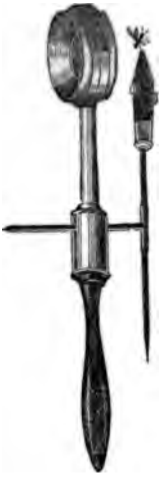
Comic Sliders.—These are in great variety, representing comic scenes, sea views, &c.

Price, each, -	$1.25.
" " 12-inch,	$0.75.
" " 8-inch,	$0.38.

MICROSCOPES.

THE FLOWER MICROSCOPE.

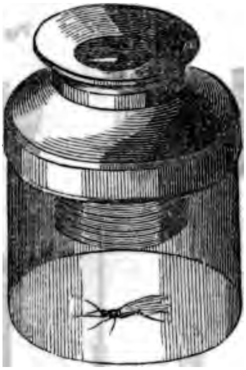
Fig. 746.



THIS instrument (Fig. 746) consist lens mounted in a brass frame, with having an ivory or ebony handle, the about three and a half inches long. Th the stem there is an arm, which is m slide smoothly, and at one end a soc which moves stiffly a steel rod ha small milled-head at one end, and a point at the other, which may be different heights, and turned about viewing the object. To use the instr the object to be viewed is placed point, and the arm moved backwar forwards in the stem till the object distinctly. This instrument is conv for viewing leaves, flowers, and p plants, &c., and may be used witho arm, as a hand magnifying glass. whole is packed in a small box. best kind there is an additional lens, may be used singly or both together, producing a co able increase and variety of power; also a pair of forceps for holding any object, is connected with the either of which may be used as may best support th ject. In using the microscope, it should be held in a way that the most light should shine on the part v

Price, with one lens and point, $1.1
" with two lenses and forceps, $1.

Fig. 747.

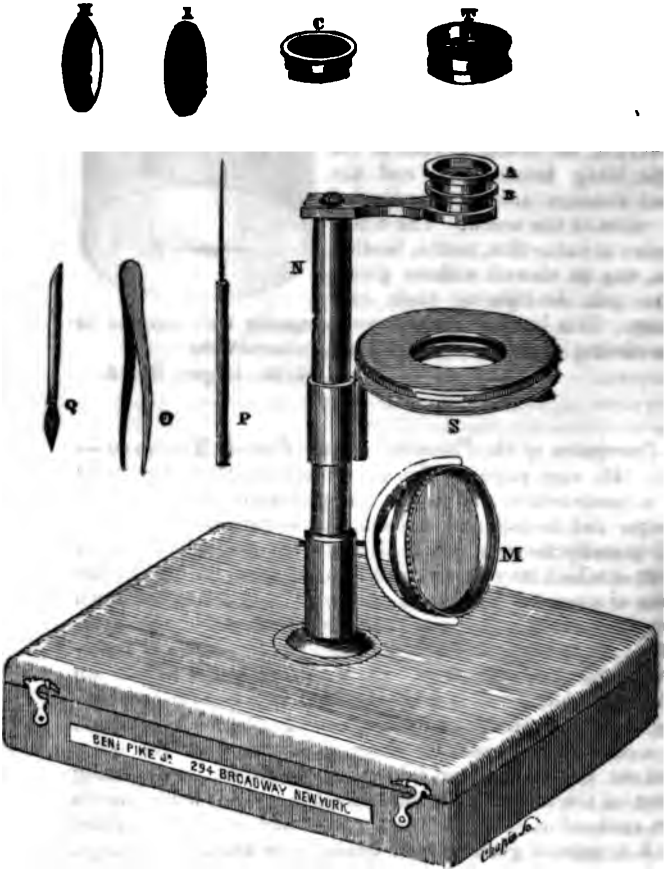


The Insect Microscope — (Fig. 7.)—This instrument consists of o lenses arranged in a tube, on e exterior of which is a screw, t the whole length, and moving a brass cap connected with a ass shade, about one and a half ches in diameter and one inch gh. By this arrangement the sect can be confined without the ht being intercepted, and the cal distance accurately adjusted means of the screw. The whole rface of butterflies, moths, beetles, c., may be viewed without giving em pain or injuring their brilncy. This kind of microscope is equally well adapted to e viewing of seeds, crystals, sand, minerals, &c.

Price, $1.00; larger, $1.25.

Description of the Universal Single Pocket Microscope.— g. 748, next page.)—This microscope is extremely simple its construction, and easy in its application to all kinds of aque and transparent objects. It is represented on the t as ready for use. A B C are three magnifiers, one or ore of which may be screwed into the arm, D. S is a flat ate or stage for holding the objects; it is slid up or down e pillar, N, to adjust the object to the focus of the magier. M is a mirror for reflecting light through any transent object on the stage. O, a pair of tongs to take up y small object. P is a needle fixed in a handle, for turng about any object on the stage while under examination. a camel-hair pencil, for cleaning objects, &c.; the other d cut pen-fashion for taking up fluids, &c., and placing em on the stage. T is an insect-box; small living insects e confined therein, between a flat and a concave glass. is a concave glass to hold fluids; it is fitted to the stage. flat glass fitted to the stage, for laying any transparent jects on, is also sent in the box. I is an ivory plate, one de black, the other white, for laying opaque objects on, ewise fitted to the stage. G is a slip of glass used in exining animalculæ and the crystallization of salts.

Fig. 748.


K
I
C
T
A
B
N
S
Q
O
P
M
BENJ PIKE Jr. 294 BROADWAY NEW YORK
Chapin Sc.

The magnifying powers in this microscope are as follow: No. 1, 36 times; No. 2, 64; No. 3, 100; Nos. 1 and 2 combined, 169; Nos. 1 and 3, 256; Nos. 2 and 3, 400. Nos. 1, 2, and 3, 676—superficial measure.

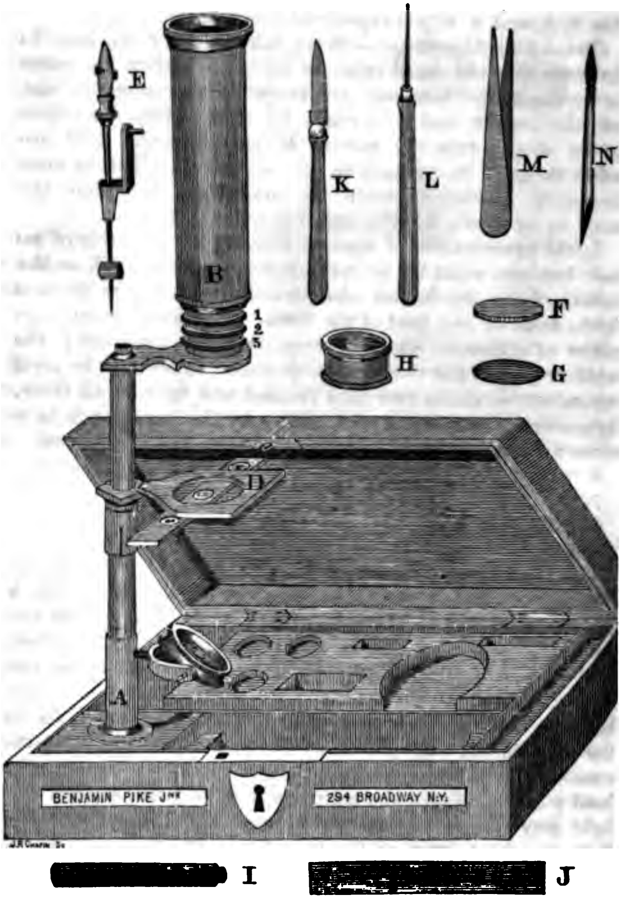
To use this Microscope.—When taken out of the box, fit the stage into the small tube by the pin. Screw the pillar on the top of the box, and the magnifier you intend to use, into the arm D, and it is ready for use. Place the object on the stage; turn the mirror, M, to reflect the light upwards through the objects to the eye, at A. This is done best while looking through the magnifier; now slide the stage up or down, till the object is quite distinct.

In the examination of opaque objects, the mirror is of no use; but you must let as much light as possible fall on the surface of the object, and take particular care not to shade it by the head or any part of the dress. There are three magnifiers of different foci belonging to the microscope; the smallest power has the largest aperture. They may be used separately, or either two may be used at a time, or all three, by screwing them one on the other; by this means you have seven different powers. Price, - - - $5.00.

" without mirror, $3.50.

Description and Manner of Using the Single or Compound Microscope.—(Fig. 749, next page.)—Screw the pillar A into the box, and the magnifiers, 1 2 3, into the arm at the top. The magnifiers are of different powers, any one, two, [illegible] the three may be used; when three are used, the one [illegible] the smallest glass should be screwed in first. The body, B, containing the eye glasses may be screwed on to the magnifiers; the power of the instrument may be increased, by making the body longer with drawing out the head a little. Place the microscope in a position that the light may fall on the mirror, C, and adjust it so that the light may be thrown on the object placed on the stage, D, which slides on the pillar by which the microscope is adjusted to the proper focus: E, a pair of forceps, which are opened by pressing the studs; any small object may be held by them and fixed to the stage: F, is a plate of ivory which fits in the stage, and is used for opaque objects; the black *side for white* objects, and the light side for dark

Fig. 749.

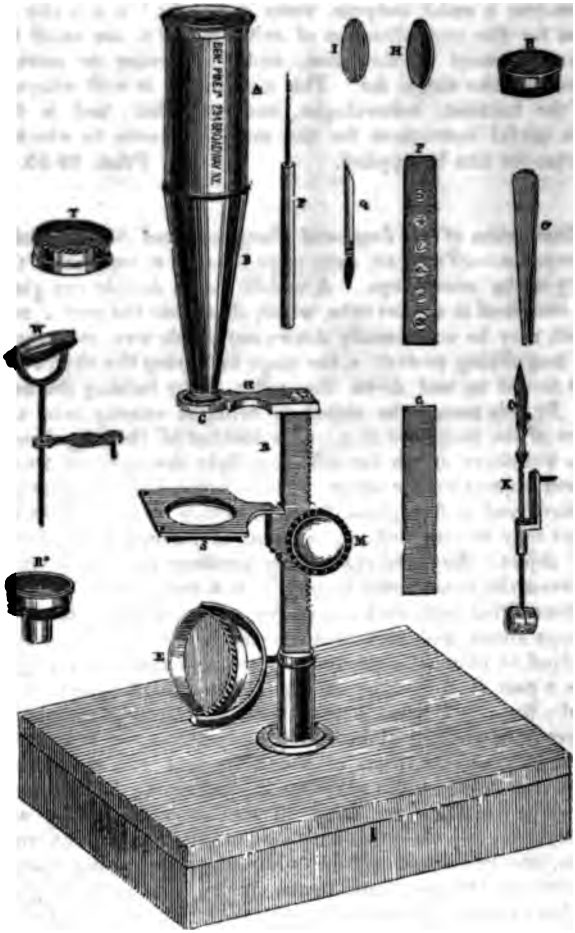

E
B
1
2
3
K
L
M
N
F
H
G
D
A
BENJAMIN PIKE JNR
294 BROADWAY N.Y.
J.R. Chapin Sc
I
J

objects: G, is the meniscus glass for fluids or transparent objects: H, is a box for containing animalculæ or any small living objects, which also fits the stage: I, is a glass tube to enclose a small tadpole, water newt, &c.: J, is a slip of glass for the crystallization of salts: K L M N, are small instruments used in dissection, and for turning or moving objects on the stage, &c. This microscope is well adapted for the botanist, mineralogist, and naturalist; and is the most useful instrument for the many purposes to which a microscope can be applied. Price, $9.50.

Description of the Improved Compound and Single Pocket Microscope.—(Fig. 750, next page.)—A, B, C, represents the body of the microscope. A middle and a double eye-glass are contained in a short tube, which slides into the part A, and which may be occasionally drawn out a little way, to increase the magnifying power: S, the stage for laying the object on; it is moved up and down the pillar, N, by turning the nut, M. By this means the object is brought exactly into the focus of the magnifier at C: R, is another of the magnifiers: E, is a concave mirror for reflecting light through any transparent objects on the stage: T, is a brass box containing a concave and a flat glass, between which any small living insect may be confined: K, is a pair of forceps for holding any object; they are opened by pressing the small studs between the thumb and finger: L, is a small ivory cylinder or brass filled with cork; it serves as a handle to turn the forceps about, and also to stick any insects on, which may be fixed on pins; the pin fits into the small hole in the stage: O, is a pair of tongs, for taking up any small object: P, a needle fixed in a wood handle, used for turning about any object on the stage while under examination: F, is a slider, containing objects, three of which are sent with the microscope: H, is a concave glass for holding fluids, it is fitted to the stage; a flat glass fitted to the stage for laying any transparent objects on, is also sent in the box: I, is an ivory plate, one side black and the other white, for laying opaque objects on, likewise fitted to the stage: G, is a slip of glass used in examining animalculæ, and the crystallization of salts.

To use the Microscope in its Compound State.—When taken out of the box, screw the pillar into the top of the box, the body, A, B, C, into the magnifier you intend to use,

Fig. 780.


BENJ PIKE JR 294 BROADWAY N.Y.
A
I
H
R
F
Q
P
O
T
B
W
G
C
D
G
O
K
S
M
R'
E
L

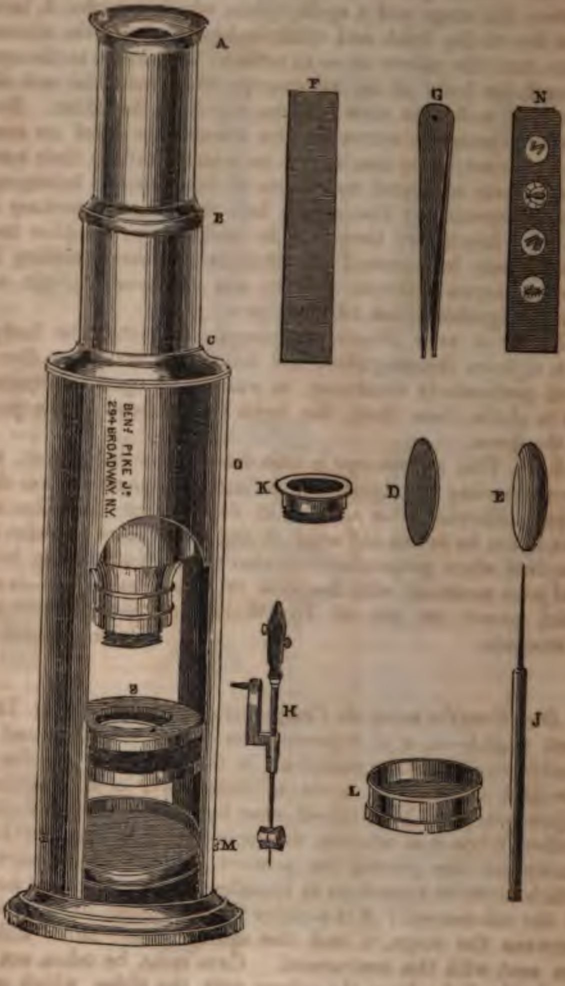
which must be first screwed into the arm, D, and it is ready for use. Now push the slider with transparent objects between the stage and a spring plate which is under it, turn your face to the light, and while looking through the microscope, turn the mirror so as to reflect the light up to the eye through the body of the microscope, then turn the nut till you have a distinct view of the object in the slider. For opaque objects the mirror in this microscope is of no use, but you must let as much light as possible fall on their surface. There are three magnifiers of different foci belonging to this microscope; that which has the largest aperture is the least magnifier; they may be used singly, or either two of them may be screwed together, or all three, making in this way seven different powers, the compound power of which magnifies about 18,000 times.

To use it as a Single Microscope.—Unscrew the body, A, B, C, from the magnifier, and follow the foregoing directions, particularly observing, in examining opaque objects, not to shade them from the light by the head or any part of the dress.

N. B. This microscope is also fitted up with the part, W, for condensing the light from a lamp or candle upon the object; likewise with a joint at the base of the pillar, so that it can be set at any angle, being much more pleasant to use than when perpendicular; also with tripod folding feet, and joint mounted with doublets or achromatics. R° is an extra power, or one of Dr. Wollaston's doublets, or an achromatic. Price, $15.00.

Directions for using the Compound Microscope.—(Fig. 751, next page.)—A, B, C, represent the body; a middle and a double eye glass are contained in the tube which slides in the part A, which is made to slide easy, so that a finer adjustment may be obtained than by sliding the body altogether, when it is set near the focus; and the further it is drawn out the greater the power: M is a concave mirror, which must be turned so as to reflect the light up the body of the microscope: N is a slider (with objects) to be placed between the stage, S, and the spring plate; three sliders are sent with this instrument. Care must be taken not to shade the light from the mirror with the slider, which may be avoided by placing the slider any otherwise than straight

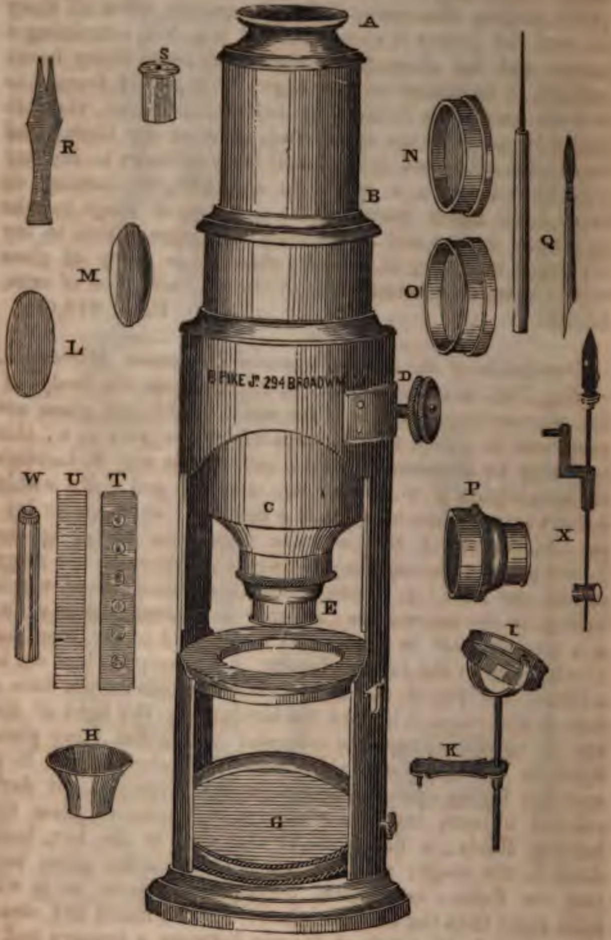
Fig. 751.



across: K is a magnifier, three of which are sent with this microscope; that with the largest aperture is the least magnifier. They may be used singly, or either two, or altogether, making thus seven different powers; when all three are used the power is very great: L is a box, containing a concave and flat glass, for confining any small living insect between, to be placed on the stage: H, a pair of forceps to fit in the small hole in the stage to hold insects, &c., they are opened by pressing the small studs between the thumb and finger; the other end has a small ivory cylinder to lay any small object on: J, a needle in a handle, for turning an object while under examination: G, a pair of tongs to take up insects, &c.; D and E, are ivory and glass plates to lay any object on; they fit into the stage: F is a slip of glass used in examining animalculæ, or the crystallization of salts, &c. &c. Price, $10.00.

Description of the Large Improved Compound Microscope.—(Fig. 752, next page.)—A, B, C, represent the body of the microscope, a middle glass and a double eye glass are contained in a tube which slides within the part A, B; this tube may be occasionally drawn out a little way to increase the magnifying power; the body slides up and down within a short spring tube at D: F, is a flat plate or stage for laying objects on: G, is a concave mirror for reflecting the light upwards through any transparent object on the stage to the eye at A: E, is one of the magnifiers, six of which belong to the microscope; another is represented at P: H, is a magnifier set in brass, it is to be held in the hand for viewing any of the larger objects: I, is a convex lens set in a frame, the pin of the arm, K, which holds it, fits into a hole in the stage, it is used for condensing the light of the sun or candle on opaque objects: L, is a flat ivory plate fitted to the stage, one side black, the other white; it is used for laying opaque objects on, the white side for dark colored objects, and *vice versa:* M, is a concave glass for holding fluids; a flat glass is also sent in the box, both fitted to the stage: N, is a brass box with a flat glass bottom for fluids; very useful for aquatic objects, as it will hold more than the concave glass: O, is an insect box, small living insects are confined therein between a concave and a flat glass: Q, is a needle fixed in a wood handle, it serves for turning about any object on the stage while under exam-

Fig. 752.



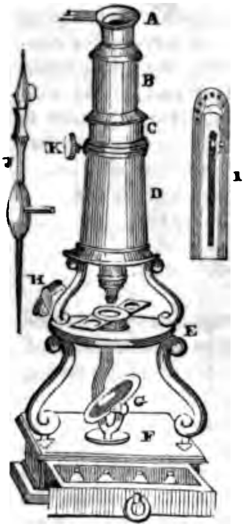
mation: R, a pair of tongs for taking up any small object: S, a small box for holding a little talc, and rings to replace objects in the slides: T, a slider for holding objects, six of which are sent with the microscope: U, a slip of glass used to lay any objects on, and particularly useful in viewing animalculæ and the crystallization of salts: W, a glass tube to confine a small fish, water-newt, or tadpole, for viewing the circulation of the blood: X, is a pair of forceps for confining objects, they are opened by pressing the small studs between the thumb and finger: the other end of the wire is pointed for sticking objects on; a small ivory cylinder is fixed to this end, it serves also as a handle to turn the forceps about, and also for laying any very small objects on.

The magnifying power of this instrument is with the

No. 1.	22,500.	No. 4.	1,600.
2.	8,100.	5.	900.
3.	3,600.	6.	450.

To use the Microscope.—Screw the magnifier you intend to use to the bottom of the body at E; the readiest way of doing this is to draw the body entirely out of its spring tube; push one of the sliders with transparent objects between the stage and a spring plate which is under it; face the light, and while looking through the microscope, turn the mirror so as to reflect the light upwards to the eye at A. The part C, has the same Nos. engraved on it as the magnifiers, which must be set to correspond with the magnifier in use; then by turning the nut, Y, a fine adjustment may be obtained. There is a certain direction of the mirror in which the object appears better than in any other, and which may be easily discovered with a little practice. In the examination of opaque objects, the mirror is of no use, but the surface must be enlightened as much as possible; this can be very well performed in this microscope by directing the rays of the sun, or a candle, through the convex lens, I, on the object; for this purpose the lens is to be fitted to the stage, and if a candle be used, it must be placed so as to refract the light through the lens strongly on the object. A few trials will make it easy, as the lens may be turned any way, or raised and lowered in its frame. By day and without the sun this lens is of no use, so that opaque objects can only be enlightened by placing the microscope in a *good light,* and it will not be possible to magnify them so much as when more light is thrown on in the way just described. This lens serves also to magnify any large flower, or other object. Price, $20.00.

Fig. 753.

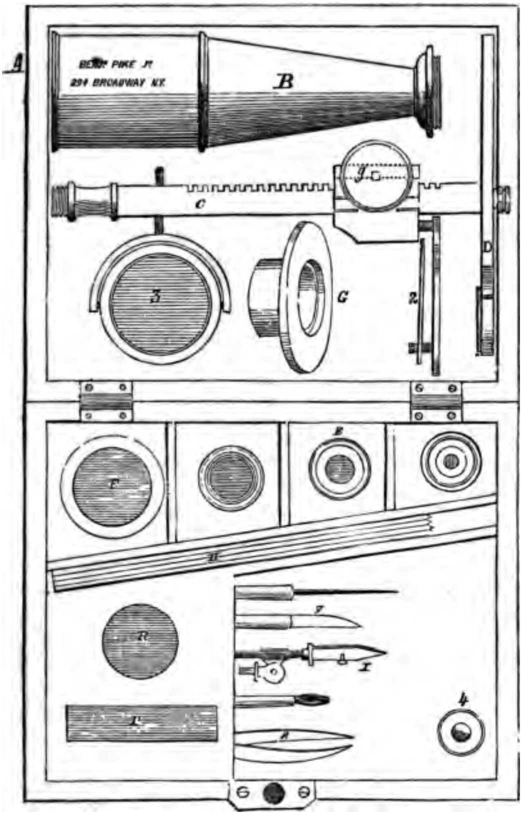


Culpepper Microscope.—(Fig. 753.) This instrument is one of convenient form, possesses considerable power, and was at one time almost the only one sought after. It is shown in the cut as set out for use; it stands twelve or fourteen inches high, and has four or six different powers. A, is the slide-head, turned concave; B, the eye tube, containing two powerful lenses; C, the slide tube by which the instrument is adjusted; D, the body in which the upper part slides, having in some cases a rack and pinion movement at K; E, is a circular brass table, supported upon three legs, which are screwed upon the stand, F. In the middle of E is a spring object holder; G, the mirror which reflects the light through the object to the eye; H, an illuminator or lens, for reflecting light upon opaque objects; I, is a contrivance called the frog plate; and J is the nippers and needle.

Price, $15.00 to $25.00.

Gould's Improved Pocket Compound Microscope.—(Fig. 754, next page. —The extreme portability and great magnifying power of this microscope will recommend it strongly to the naturalist, mineralogist, and botanist, as it has sufficient powers to discover minute animalculæ and seed-vessels. It combines the uses of the single, compound, opaque, and aquatic microscopes; and has been found, upon comparison, by several scientific gentlemen, superior in power to, and more distinct, than many of the larger and more expensive instruments of the kind. It shuts up in a case three inches *by three and a half*

Fig. 754.



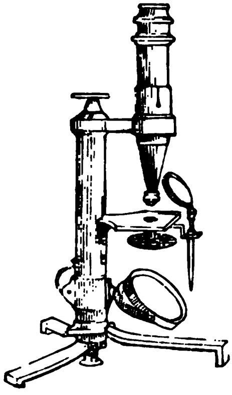
Description of the Plate.—A, the microscope, as it lies in case, the body and pillars taken out, to show the appa- us beneath. B, the compound body. C, the pillar on ich is fixed the stage, fig. 2, and reflecting mirror, fig. 3. ese remain on the pillar when put into the case, for the ivenience of packing. D, the arm, may be taken off and d as a hand microscope, fig. N. E, the different powers, s. 1, 2, 3. These are screwed on to the arm, and in them *body, but each* may be used singly for large or opaque objects without the body. Nos. 1 and 2 may be combined: No. 3 is not to be combined with either, but used singly; the No. 4, in the small flat cell, is the higher power, and is to be used with or without the body for extremely minute transparent objects. F, the object-box, which unscrews to place live objects in, such as mites from cheese; this is placed on the stage. G, a movable piece, to place on the stage, fig. 2, for holding objects. H, slides filled with curious objects. I, a pair of steel-pointed forceps, which open by pressing the two brass pins, for holding flies, or pieces of card with opaque objects on them; this is placed in the hole on the stage or on the arm, when used as a hand microscope, fig. N. K, a dissecting-knife and point; a pair of brass forceps, for taking up small objects, with a spoon at the end for taking up a single drop of water, for placing between the two glasses to view the animalcule; a small brush for taking the mites from cheese, farina from flowers, and other delicate objects. L, the whole instrument put together for use. N, the arm converted into a hand-microscope. P, two pieces of glass sealed together for holding a drop of water. R, a circular piece of glass for placing on the stage G, to hold any object.

Directions for putting the Microscope together.—First take out the pillar, on which is fixed the stage and reflecting mirror; screw it on the brass-piece on the side of the box; turn the mirror to face the light, and move the stage to the centre of the pillar by means of the rack and pinion; place one of the powers on the body, and screw it into the arm: you must now get a clear and distinct field; this you will obtain by moving the mirror to the proper angle to reflect the light, at the same time looking through the microscope; now place the object to be examined on the stage; get the proper focus of the lens by moving the stage up and down by means of the milled-head, fig. 9. To place the slides in the stage, press down with the fingers the brass spring underneath; as an improvement for viewing objects generally, the movable piece, G, is placed upon the fixed stage, fig. 2; it may be moved by the finger and thumb, with the greatest delicacy, in any direction; the object to be examined being placed upon the circular piece of glass. To place the pillar again in the case, let the stage be brought close up to the arm, and the mirror turned round; they will then fit into their place without being separated from the pillar. It is more difficult to get the reflected light with the candle than by day light, but many of the objects appear to much greater advantage; the candle should be placed at the distance of about twelve inches, not too high, and in a straight line with the mirror.

Description and Application of the Different Powers.—This microscope has five different powers, so arranged that objects may be viewed from the size of a large beetle or moth to the most minute animalculæ. These powers are marked Nos. 1, 2, 3; No. 1 is the lowest power, and is calculated for viewing opaque and large objects, and should be used without the body. No. 2 is the next power, and is calculated for viewing all the objects of the size of those in the slides; the next power is produced by combining the Nos. 1 and 2 together, which may be called the third power; it magnifies 2,500 times, and is adapted for viewing the animalculæ, &c. The fourth power is in a conical cell, marked No. 3; with this power an object is magnified 26,000 times with the body; the fifth or greatest power is in a flat cell, and magnifies an object 62,500 times with the body, which is equal to the largest compound microscopes; it should only be used for extreme minute objects, and without either of the other powers; as the object and the lens come extremely near when it is used, care must be taken, by a very delicate movement of the stage, that they do not come in contact with each other in getting the proper focus. To prevent this, if a drop of water is to be examined, place it between the slips of glass, and if these will not permit the lens to come near enough, place a piece of thin talc upon a piece of glass. Objects should first be viewed with the low powers, that the whole of them may be seen, and the higher ones can then be used in gradation.

Achromatic Microscope.—One of the most valuable contributions to the science of the microscope is that of the introduction of achromatic object-glasses to these instruments. These lenses represent the object better defined, and clearer, and also free from the tints and coloring, usually found in other instruments; and although they have but recently come into use, their great superiority is unquestioned, the only bar to their more general use being the great addition in cost. *Fig.* 755, next page, represents a modern

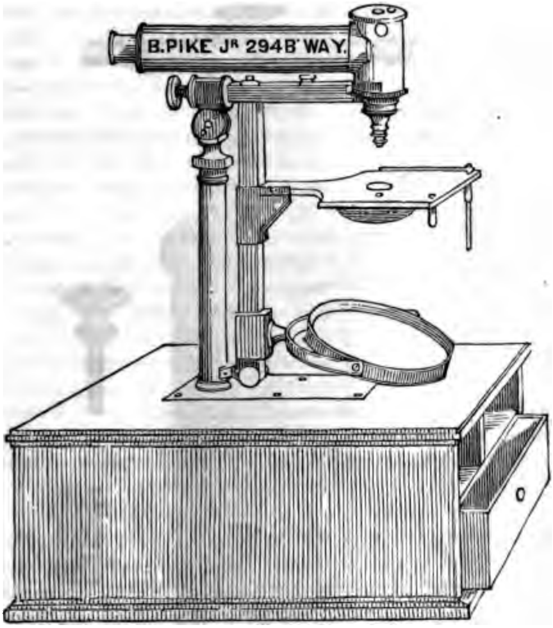
Fig. 755.



style of achromatic microscope. It is mounted on a tripod stand, the legs of which fold under each other, for portability, when packed in its case. The various parts, viz. the reflector to illuminate the object to be viewed; the stage, with its various appendages for holding the object; and the eye-piece, with the different powers, are supported on a cylindrical column, an adjusting motion being given to the stage, in a very superior manner, by the milled-head screw, at the top of the column. With this instrument there are five achromatic object-glasses, of different powers, an illuminator for opaque objects, set of prepared objects, dissecting instruments, &c.; the frame-work made of brass, highly finished, and the whole packed in a polished mahogany case. Price, $70.00.

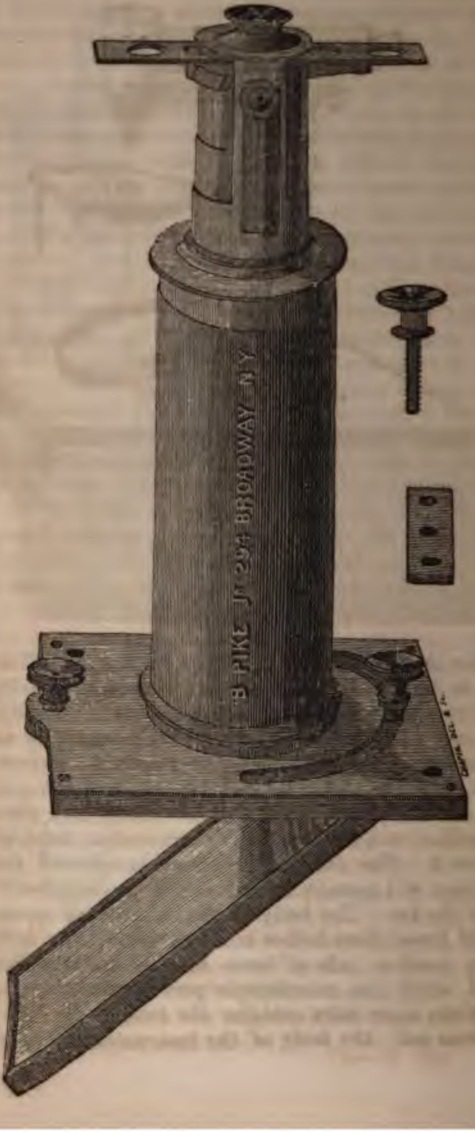
Improved Achromatic Microscope.—(Fig. 756, next page.) —This figure represents one of the latest and most improved achromatic microscopes, uniting all the modern improvements; it being either a vertical microscope, according to the usual style, or a horizontal one, having the improvements of Prof. Amici. Attached to the instrument there is also a camera lucida, by which an accurate drawing of any object viewed in the microscope may be taken. The figure represents the instrument arranged as a horizontal microscope, being the one most convenient for observation, as well as the least fatiguing to the observer; the instrument being placed on the table about the height of the observer's eye. The various adjustments to the instrument are of the most accurate kind. There are two eye pieces of different powers, six achromatic object glasses of different focuses, illuminator, a camera lucida, a micrometer, objects, dissecting instruments, &c. The whole finished in the most superb manner; the box of polished mahogany having three drawers for containing the various parts, into which they may be securely *packed.* Price, $125.00 to $150.00.

Fig. 756.


B.PIKE J^R 294 B'WAY.

Solar Microscope.—(Fig. 757, next page.)—This instrument in its principle is composed of a tube, a looking-glass or mirror, a convex lens, and a single microscope. The sun's rays being reflected through the tube, by means of the mirror, upon the object, the image or picture of the object is thrown distinctly and beautifully upon a screen of white muslin, placed from five to twenty feet distant, and is magnified to a size not to be conceived by those who have not seen it. The further the screen is removed the larger the object will appear, though it will be brighter if not removed too far. The body of the microscope consists of a tube of brass three inches in diameter and ten inches long, having another tube of brass moving easily within, to the end of which the microscopic part is attached; the other end of the outer tube contains the condensing lens secured in a *brass cell; the* body of the instrument is screwed to a

Fig. 757.


B. PIKE Jr 294 BROADWAY N.Y.

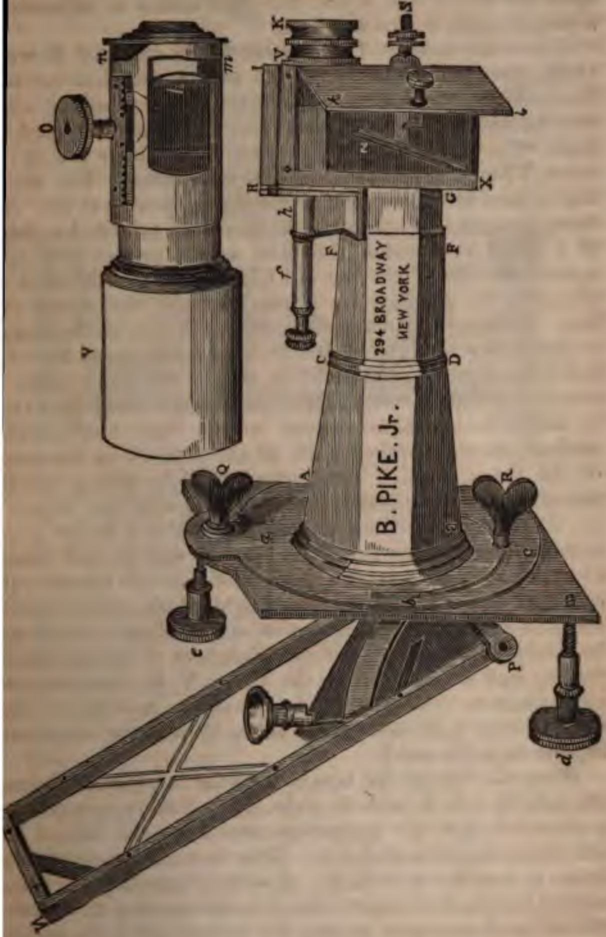
ame of mahogany eight inches square, which is covered r a stout brass plate, sunk in between which there is a ass plate, or wheel, cut with teeth on its circumference, id movable by a pinion having a large milled-head outside e plate, by which it may be turned nearly round; to this ate there are fixed short arms projecting through a circular ening in the mahogany frame which extends nearly round, id supporting a brass frame five inches wide and eleven or relve inches long, containing a mirror having a toothed heel attached, against which works an endless screw procting through the mahogany frame and brass plates, and rminating in a milled-head, by which it may be elevated depressed. Thus by turning those two milled-heads, the irror may be turned in any direction required for reflectg the solar rays through the condensing lens, and illuinating the object. The microscopic part consists of three bes fitting easily the one over the other; the inner one ntaining a lens for further condensing the rays received om the large lens; on the outer end of this and the middle be, there are brass plates with openings of about half an ch in the centre, and are kept together by a stout spiral ring within the inner tube, between which plates the ider containing objects is held, portions of the outer and iddle tube being cut out to allow of their introduction. the end of the outer tube, the cells containing the magfying lenses are screwed; three of which accompany the strument, having different powers. To the outer tube ere is a small rackwork of tooth and pinion by which the agnifyers may be moved gradually to or from the object, ljusting them exactly to their focus of different lengths. set of objects accompany the instrument. The body of ie instrument and microscope tube unscrew, and the whole packed in a neat mahogany case with lock.

Price, with 3 inch condensing lens, and 1 rack motions, arranged as above described,	$50.00.
" with 3 inch " " and 1 " "	$42.00.
" " 5 " " " " 3 " "	$75.00.
" " 2 " " " " 3 " " the frame wholly of brass, - -	$40.00.
" " 2 " " " " 1 " "	$35.00.
" " 3 " " mounted in a simpler manner, - - - - -	$25.00.

To use the Solar Microscope a window must be selected into which the sun is shining, and a hole is made in the window shutter, or in a board provided for the purpose, of about six inches in diameter, and by means of two brass nuts let into the shutter to receive the milled-head screws; when passed through holes in the corners of the square frame, firmly fasten the microscope to the shutter, the mirror extending outside. The room is to be darkened as much as possible, that no light may enter but what passes through the body of the instrument. The mirror is to be turned by the milled-head screws, till the beams of the sun's light pass directly through the tube, and form a large and brilliant circle of light on the screen, which may be placed at a distance of ten to twenty feet; the screen is formed of white muslin, and the object may be seen with equal distinctness on either side. The slider, containing the object to be magnified, is placed between the plates in the microscopic tube, where it is held by the pressure of the spiral spring. It now remains only to adjust the magnifier, that the image on the screen may be the most distinct or perfect, which is done by moving the pinion a small distance one way or the other. If the object is rather large, the least magnifying power is used, if small the greater.

Solar Microscope for Opaque and Transparent Objects.—(Fig. 758, next page.)—The body A B C D E F has the part A B C D of a conical, and the part C D E F of a tubular form. A large convex lens is placed at A B, at the end of the conical tube A B C D, which screws into the square plate Q R, which is fastened to a window-shutter opposite a hole of at least the size of the lens A B, by means of the screws, *e*, *d*. Upon the square plate, Q R, there is a movable circular plate, *a b c*. To this circular plate is attached the silvered glass mirror, N O P, placed in a brass frame, which moves round a joint, P P, and which may be placed in any position with regard to the sun, so as to reflect his rays into the tube A B C D, by means of rack-work and pinions at Q and R. The pinion, Q, moves the circular plate, *a b c* (to which the mirror, N O P, is fixed) in a plane perpendicular to the horizon, while the nut, R, gives it a motion in an opposite plane. The light introduced by this mirror falls upon the lens, A B, which throws it in a condensed state upon any object in the tube. But before it reaches

Fig. 758.

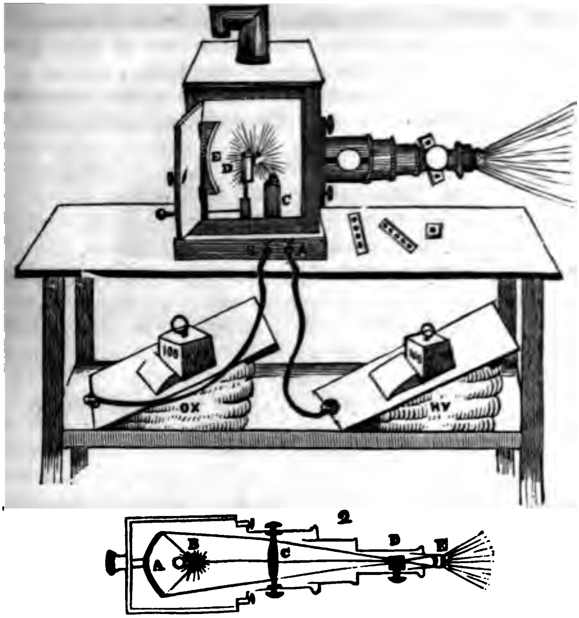


the opaque object, it is received by a mirror, M, placed in the box, H I L X, which reflects the condensed light back upon the face of the object, E. This mirror is adjusted to a proper angle by the screw, S.

Above the body A B E F is seen the part *f* V K which carries the sliders or objects, and the object-glass or lens. The tube, K, slides within the tube, V, and V again slides into the box, H I L X. These tubes carry each a magnifying lens. The inner tube, K, is sometimes taken out of the other, V, seen within the box, and used alone. The sliders and objects are introduced into a slit or opening at H. The brass plate to the left of H is fixed to a tube *h*, by means of a spiral wire within the tube, which presses the plate against the side of the box H I L X, so that the sliders, when placed in the opening, are pressed against the side of the box. In using this microscope, the sun's rays are first made to pass along the tube, A B C D, by the nuts Q and R. The box for opaque objects, H I L X, is then slid by its tube, G, into the tube, E F. The slider containing the object, having its face to be examined turned to the right hand, is then pushed into the opening at H, till the object is in the centre of the tubes, V, K. The condensed light falling on the mirror, M, is then thrown back on the face of the object in the slider, and the door, *k i*, shut. Upon a white paper screen or cloth, from four to eight feet square, and placed at the distance of from six to ten feet from the window, the observer, in the room made thoroughly dark, will see on the screen a magnified representation of the object, which may be rendered distinct at different distances of the screen, by pulling out or pushing in the tubes, V, K, containing the convex lenses. As the sun is constantly moving, its rays must be kept in the axis of the tubes by now and then turning the nuts, Q and R.

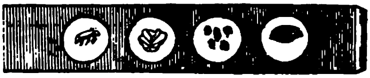
When the microscope is to be used for transparent objects, the box, H I L X, with its tube, G, and other appendages, is removed, and the apparatus shown at the side of the instrument substituted for it. This is done by sliding the tube, Y, into the tube, E F. A slider containing the magnifying lens is then slipped through the opening at *n*, and a second condenser may or may not be inserted in the opening at *h*. The slider with the object is then placed in the opening, *m*, and when its magnified picture falls upon the screen, it is adjusted to distinctness by turning the milled nut, O.

Fig. 759.



Oxy-Hydrogen Microscope.—(Fig. 759, as above.)—This is a valuable instrument of public exhibition, so called because the light is formed by the action of hydrogen, thrown in an ignited state upon a cylinder of lime; its flame being at the same time urged by a jet of oxygen, or rather the two gases are previously mixed together, and thrown upon the lime. The instrument in other respects nearly resembles the magic lantern. Fig. 1 shows the whole complete: A and B are two cocks, connected with the gas bags holding the gases, one of which is twice the size of the other—twice the quantity of hydrogen being necessary. These cocks are connected with the blow-pipe chamber, C; from the top of which a jet conveys them against a small cylinder of lime, D, producing an intense white light, which is reflected by the reflector, E, on to the lenses in the tube of the instrument. Fig. 2 shows the best method of arranging the glasses; A is here the reflector; B the light; C a double convex lens, to condense the light upon the object; D the slider of objects; E, two plano-convex lenses, forming an achromatic eye-piece, through which the rays of light pass, and depict the object of an immense size upon a screen prepared to receive it, in the same manner as in the exhibition of the magic lantern. Price, $80.00 to $150.00.

Fig. 760.



Microscope Sliders.—(Fig. 760.)—These consist of a flat strip of ivory, having four round holes wherein to place small objects between two pieces of talc, or isinglass, which are confined by a small spring ring. Several such sliders usually accompany microscopes of good quality.

Price, a set of 6 sliders, $3.00.

Directions for procuring and applying the most interesting Subjects for Examination by the Microscope; also the method of procuring those wonderful Objects of the minute creation, the Animalcula in Vegetable Infusions.

MANY persons who have purchased microscopes, after entertaining themselves and friends with the slides that accompany the instrument, have found themselves at a loss for new objects, and consequently, have laid it aside as of little further use. No invention is capable of affording more entertainment and instruction than the microscope; it opens a new world, and displays the most extensive scenes of creative power, wisdom, and design.

Objects for the Microscope.—In the summer months, the waters, as well as the fields, abound with living wonders for the microscope, and afford an endless amusement to the admirers of the works of nature in the minute creation.

Best method of procuring Aquatic Insects.—In the ponds and ditches that are covered with duck-weed, surprising insects may be found; some of the weed should be procured, and put into a white earthen vessel; it will yield a never-failing supply of living and most entertaining objects for the microscope, and may be kept the whole of the winter months, as the leaves have the valuable property of keeping the water fresh. Every proprietor of a microscope, who would wish to secure a supply of a great variety of interesting living objects in constant readiness, should adopt this method of obtaining them. The decayed leaves will be found best for the purpose; two or three of these being taken out, with a small portion of water, on a piece of glass, gently press them, and the wheel animal, as well as many others, will come out from the cells in which they have taken up their abode. The bell-shaped polype, the proteus, and other smaller kinds of animalcula, may thus be had in great numbers.

Those that are visible to the eye may be easily procured by the aid of a small landing-net, made with stout wire and book-muslin; bend one end of the wire into a circle, and secure it by twisting; the other end will serve for a handle, by which it can be attached to a stick; when used, suffer the water to drain away, then reverse the instrument, touching the water (into which the insects are to be transferred) with the muslin, by which means they can be so transferred without injury by handling; a small instrument, about 1¼ inch diameter, will be found very serviceable, upon the same plan, in fishing out the insects; when about to be exhibited, put some clear water in a watch-glass, and reverse the net with the insects into it; any one of them singly may be taken out by means of the small spoon or brush, for examination.

Beetles, Moths, &c.—Numbers of these may be found by attentively examining the hedges in lanes; almost upon every leaf you may discover some minute living creature. On the grass a great variety of the beetle tribe may be procured, under stones, in the old trunks of trees, in the bark among the heaths and mosses, and in sand-pits; and a great variety of wings and other parts of insects may be found on the webs of the field spiders, most beautifully dissected for the microscope, in a way that could not be done by any other *means.* Mosses and vegetation on old walls, contain many rare and curious microscopic insects; a quantity of this moss should be procured, put into boxes and afterwards carefully shaken over a sheet of white paper

Apparatus for collecting Objects.—These are simply as follows:—A net of wire gauze for taking insects on the wing. It may be held, also, expanded under a tree or bush, whilst the branches are beaten with a stout stick, which will cause a number of curious insects to fall into it; a landing-net for aquatic insects; a knife for extracting objects from the roots of trees, bark, &c.; a strong phial, corked, with a quill passing through it, for water insects; a tin box, the cover pierced with small holes; a few chip boxes.

Directions for dissecting Objects.—In dissecting minute insects, as the flea, louse, &c., in order to examine their internal structure, it is necessary to observe great care; they should be placed in a drop of water, and examined instantly, or the parts will shrink up. A delicate lancet, with a pair of the finest scissors and forceps, are generally used for such purposes.

Method of preparing and applying Objects for the Microscope.—Most objects require a little management in order to bring them properly before the glasses; if they are flat and transparent, put them between the talc in the slides—the scales of fishes, for instance, &c. In making your collection of objects, if you wish to fill a number of slides, care should be taken to arrange them as near the size of each other as possible in the same slider, in order that they may be examined by the same power. Minute living objects, such as mites in cheese, small insects on vegetables, &c., should be delicately brushed off into the object-box, and shut up; flies and small beetles may be held by the forceps.

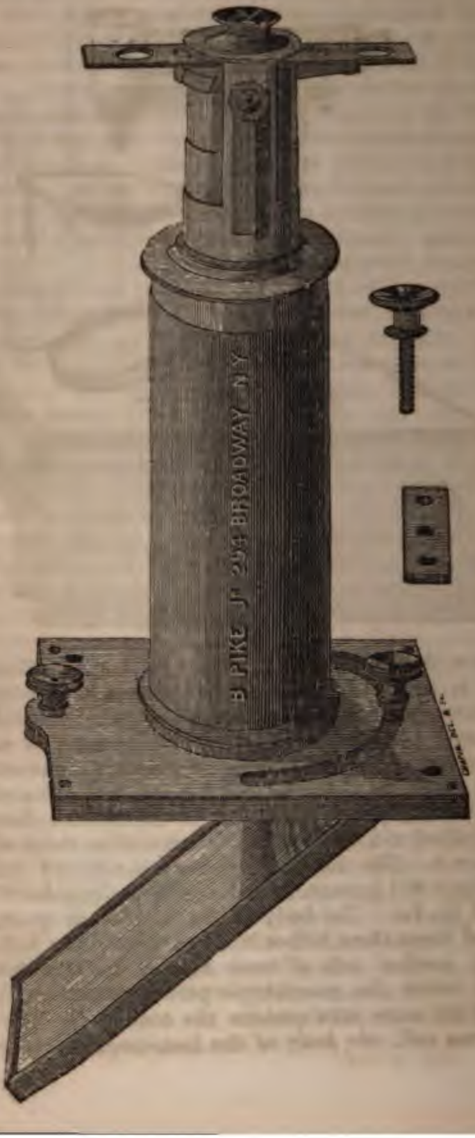
To view the circulation of the blood, &c., in aquatic insects, place them in a small portion of water on a piece of flat glass; two pieces of glass may be made open enough to receive any sized objects of this kind, similar to the animalcule apparatus.

Method of viewing Animalcula in Fluids, with the greatest facility.—The great difficulty of viewing animacula in fluids must have been felt by all who use microscopes. A drop of water placed on a piece of glass forms a convex surface, and when a high power is used, the animalcula are continually getting out of the focus by diving to the bottom, and the drop very soon dries up.

The following contrivance effectually removes these obstacles when the focus of the power in use will admit one of the pieces of glass to intervene between the surface of the lens and the object. It consists of two pieces of glass fixed with a small portion of sealing-wax between them, and left open at the top. For viewing animalcula, these pieces should be pressed as close together as possible, but for larger insects they may be left more open. If a single drop of water is taken up by the small spoon at the end of the forceps, and spread over the orifice, it will run in between the two glasses, by which means the surface of the water is rendered perfectly even, and the animalcula are distributed more truly, and confined in a more limited space whereby their forms and movements are more discernible This plan also prevents evaporation from the surface, which often dims the lens and perplexes the observer; a single drop of water may be kept for hours in this way, with any curious animalcula alive in it. The glasses can be cleaned out by introducing a piece of thin writing paper between them, and a drop of pure water. By leaving sufficient room between the glasses, the larger aquatic insects may be viewed; such as small tadpoles, the ephemera, and the water flea. When animalcula and other minute objects are viewed with a lens of short focus, the following contrivance is simple and useful; upon a suitable piece of glass describe a circle with white paint; when dry, place the drop of water within the circle, and cover it with a very thin piece of talc, the space between the talc and the glass, produced by the paint, affords sufficient room for the animalcula to move, the talc (if sufficiently thin) offers no obstruction in bringing the object to the focus of the lens.

Slides for Transparent and Opaque Objects.—You will find clear slips preferable to talc in forming the slides for transparent objects; they may be prepared in the following manner: take two slips of glass about the size of the ivory slides; then get a piece of writing paper with holes of the same size; wet one side of the paper with gum water, and lay the glass upon it, suffering it to dry; then place your objects in the holes, wet the other side in the same manner,

Fig. 757.


B PIKE Jr 294 BROADWAY N.Y.

submitted to the deep powers of the microscope; to separate the molecules from the glass itself, either pound it very fine, or gently rub together the unpolished edges of two pieces, having previously wetted them—the produce can then be transferred to a drop of water.

The figure of the molecules is spherical; they are so minute, that four hundred millions of them would not occupy greater space than a superficial square inch. Their motion is very vivid, and consists, not only of a change of place in the fluid, manifested by alterations in their relative positions, but also, not unfrequently, of a change of form in the particle itself; each molecule appears to revolve upon its axis: in fact, the whole of the motions are very similar to those of the most minute kind of animalcules inhabiting water.

Some persons have considered the motion to result from the evaporation of the fluid and the action of the breath of the observer upon its surface: this is proved not to be the case, by covering the water with a thin piece of talc, when the motions continue unaltered; it has likewise been urged that these spherical molecules may be hollow, and that the motion is produced by the water entering them, thereby displacing the air contained in them—were this the case the action must soon subside, which does not take place; besides, the molecules are proved to be suspended within the fluid, by bringing the surface to the true focus, when a variety of irregular particles (distinct from the molecules) will be discovered, evidently acted upon by exterior causes.

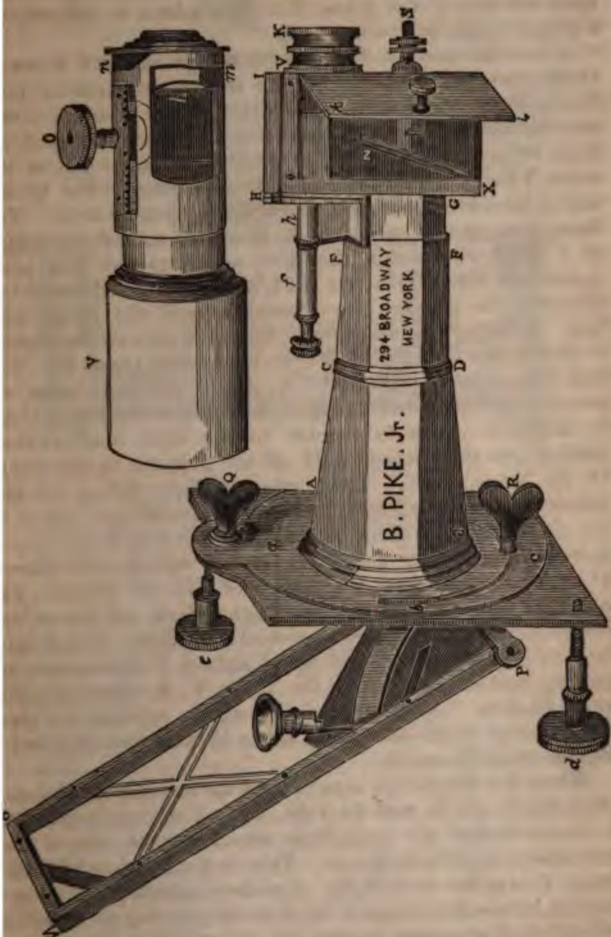
When it is considered that there is not the slightest difference in the general figure of these active molecules (let the substance be what it may from which they are separated), it will be conceded that their identity gives them a character which makes it difficult to prove their figure and motions to be the result of mere chance, exterior mechanical causes, or optical delusion.

Infusoria, or Animalcula in Vegetable Infusions.—The smallest living creatures we are acquainted with are the animalcula in fluids; they afford a wonderful scope for inquiry, and nothing is more capable of affording instruction combined with amusement, than researches into the secrets of nature in the more minute parts of her works, and they present to view most surprising wonders hitherto unknown; for who would or could have imagined that, in a

To use the Solar Microscope a window must be selected into which the sun is shining, and a hole is made in the window shutter, or in a board provided for the purpose, of about six inches in diameter, and by means of two brass nuts let into the shutter to receive the milled-head screws; when passed through holes in the corners of the square frame, firmly fasten the microscope to the shutter, the mirror extending outside. The room is to be darkened as much as possible, that no light may enter but what passes through the body of the instrument. The mirror is to be turned by the milled-head screws, till the beams of the sun's light pass directly through the tube, and form a large and brilliant circle of light on the screen, which may be placed at a distance of ten to twenty feet; the screen is formed of white muslin, and the object may be seen with equal distinctness on either side. The slider, containing the object to be magnified, is placed between the plates in the microscopic tube, where it is held by the pressure of the spiral spring. It now remains only to adjust the magnifier, that the image on the screen may be the most distinct or perfect, which is done by moving the pinion a small distance one way or the other. If the object is rather large, the least magnifying power is used, if small the greater.

Solar Microscope for Opaque and Transparent Objects.—(Fig. 758, next page.)—The body A B C D E F has the part A B C D of a conical, and the part C D E F of a tubular form. A large convex lens is placed at A B, at the end of the conical tube A B C D, which screws into the square plate Q R, which is fastened to a window-shutter opposite a hole of at least the size of the lens A B, by means of the screws, *e*, *d*. Upon the square plate, Q R, there is a movable circular plate, *a b c*. To this circular plate is attached the silvered glass mirror, N O P, placed in a brass frame, which moves round a joint, P P, and which may be placed in any position with regard to the sun, so as to reflect his rays into the tube A B C D, by means of rack-work and pinions at Q and R. The pinion, Q, moves the circular plate, *a b c* (to which the mirror, N O P, is fixed) in a plane perpendicular to the horizon, while the nut, R, gives it a motion in an opposite plane. The light introduced by this mirror falls upon the lens, A B, which throws it in a condensed state upon any object in the tube. But before it reaches

Fig. 758.

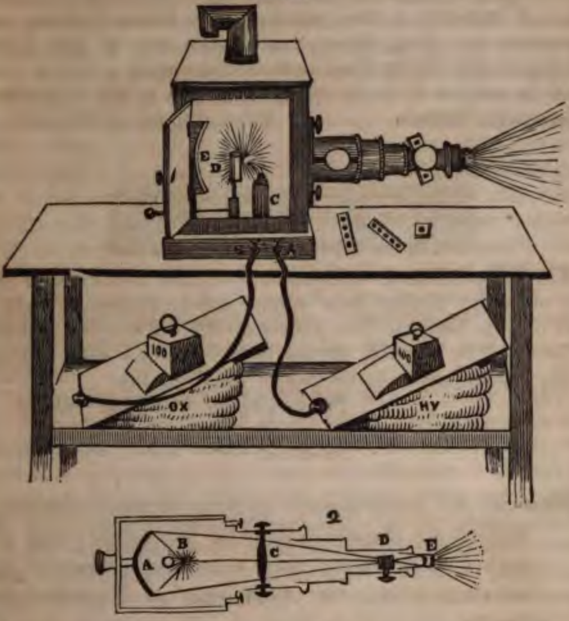

B. PIKE. Jr.
294 BROADWAY
NEW YORK
S
K
V
I
H
h
f
F
C
A
Q
R
D
E
G
X
t
z
n
m
O
Y
c
d
P
W

the opaque object, it is received by a mirror, M, placed in the box, H I L X, which reflects the condensed light back upon the face of the object, E. This mirror is adjusted to a proper angle by the screw, S.

Above the body A B E F is seen the part *f* V K which carries the sliders or objects, and the object-glass or lens. The tube, K, slides within the tube, V, and V again slides into the box, H I L X. These tubes carry each a magnifying lens. The inner tube, K, is sometimes taken out of the other, V, seen within the box, and used alone. The sliders and objects are introduced into a slit or opening at H. The brass plate to the left of H is fixed to a tube *h*, by means of a spiral wire within the tube, which presses the plate against the side of the box H I L X, so that the sliders, when placed in the opening, are pressed against the side of the box. In using this microscope, the sun's rays are first made to pass along the tube, A B C D, by the nuts Q and R. The box for opaque objects, H I L X, is then slid by its tube, G, into the tube, E F. The slider containing the object, having its face to be examined turned to the right hand, is then pushed into the opening at H, till the object is in the centre of the tubes, V, K. The condensed light falling on the mirror, M, is then thrown back on the face of the object in the slider, and the door, *k i*, shut. Upon a white paper screen or cloth, from four to eight feet square, and placed at the distance of from six to ten feet from the window, the observer, in the room made thoroughly dark, will see on the screen a magnified representation of the object, which may be rendered distinct at different distances of the screen, by pulling out or pushing in the tubes, V, K, containing the convex lenses. As the sun is constantly moving, its rays must be kept in the axis of the tubes by now and then turning the nuts, Q and R.

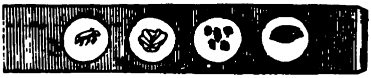
When the microscope is to be used for transparent objects, the box, H I L X, with its tube, G, and other appendages, is removed, and the apparatus shown at the side of the instrument substituted for it. This is done by sliding the tube, Y, into the tube, E F. A slider containing the magnifying lens is then slipped through the opening at *n*, and a second condenser may or may not be inserted in the opening at *h*. The slider with the object is then placed in the opening, *m*, and when its magnified picture falls upon the screen, it is adjusted to distinctness by turning the milled nut, O.

Fig. 759.



Oxy-Hydrogen Microscope.—(Fig. 759, as above.)—This is a valuable instrument of public exhibition, so called because the light is formed by the action of hydrogen, thrown in an ignited state upon a cylinder of lime; its flame being at the same time urged by a jet of oxygen, or rather the two gases are previously mixed together, and thrown upon the lime. The instrument in other respects nearly resembles the magic lantern. Fig. 1 shows the whole complete: A and B are two cocks, connected with the gas bags holding the gases, one of which is twice the size of the other—twice the quantity of hydrogen being necessary. These cocks are connected with the blow-pipe chamber, C; from the top of which a jet conveys them against a small cylinder of lime, D, producing an intense white light, which is reflected by the reflector, E, on to the lenses in the tube of the instrument. Fig. 2 shows the best method of arranging the *glasses; A is here* the reflector; B the light; C a double convex lens, to condense the light upon the object; D the slider of objects; E, two plano-convex lenses, forming an achromatic eye-piece, through which the rays of light pass, and depict the object of an immense size upon a screen prepared to receive it, in the same manner as in the exhibition of the magic lantern. Price, $80.00 to $150.00.

Fig. 760.



Microscope Sliders.—(Fig. 760.)—These consist of a flat strip of ivory, having four round holes wherein to place small objects between two pieces of talc, or isinglass, which are confined by a small spring ring. Several such sliders usually accompany microscopes of good quality.

Price, a set of 6 sliders, $3.00.

Directions for procuring and applying the most interesting Subjects for Examination by the Microscope; also the method of procuring those wonderful Objects of the minute creation, the Animalcula in Vegetable Infusions.

MANY persons who have purchased microscopes, after entertaining themselves and friends with the slides that accompany the instrument, have found themselves at a loss for new objects, and consequently, have laid it aside as of little further use. No invention is capable of affording more entertainment and instruction than the microscope; it opens a new world, and displays the most extensive scenes of creative power, wisdom, and design.

Objects for the Microscope.—In the summer months, the waters, as well as the fields, abound with living wonders for the microscope, and afford an endless amusement to the admirers of the works of nature in the minute creation.

Best method of procuring Aquatic Insects.—In the ponds and ditches that are covered with duck-weed, surprising insects may be found; some of the weed should be procured, and put into a white earthen vessel; it will yield a never-failing supply of living and most entertaining objects for the microscope, and may be kept the whole of the winter months, as the leaves have the valuable property of keeping the water fresh. Every proprietor of a microscope, who would wish to secure a supply of a great variety of interesting living objects in constant readiness, should adopt this method of obtaining them. The decayed leaves will be found best for the purpose; two or three of these being taken out, with a small portion of water, on a piece of glass, gently press them, and the wheel animal, as well as many others, will come out from the cells in which they have taken up their abode. The bell-shaped polype, the proteus, and other smaller kinds of animalcula, may thus be had in great numbers.

Those that are visible to the eye may be easily procured by the aid of a small landing-net, made with stout wire and book-muslin; bend one end of the wire into a circle, and secure it by twisting; the other end will serve for a handle, by which it can be attached to a stick; when used, suffer the water to drain away, then reverse the instrument, touching the water (into which the insects are to be transferred) with the muslin, by which means they can be so transferred without injury by handling; a small instrument, about 1¼ inch diameter, will be found very serviceable, upon the same plan, in fishing out the insects; when about to be exhibited, put some clear water in a watch-glass, and reverse the net with the insects into it; any one of them singly may be taken out by means of the small spoon or brush, for examination.

Beetles, Moths, &c.—Numbers of these may be found by attentively examining the hedges in lanes; almost upon every leaf you may discover some minute living creature. On the grass a great variety of the beetle tribe may be procured, under stones, in the old trunks of trees, in the bark among the heaths and mosses, and in sand-pits; and a great variety of wings and other parts of insects may be found on the webs of the field spiders, most beautifully dissected for the microscope, in a way that could not be done by any other means. Mosses and vegetation on old walls, *contain many rare and* curious microscopic insects; a quantity of this moss should be procured, put into boxes and afterwards carefully shaken over a sheet of white paper

Apparatus for collecting Objects.—These are simply as follows:—A net of wire gauze for taking insects on the wing. It may be held, also, expanded under a tree or bush, whilst the branches are beaten with a stout stick, which will cause a number of curious insects to fall into it; a landing-net for aquatic insects; a knife for extracting objects from the roots of trees, bark, &c.; a strong phial, corked, with a quill passing through it, for water insects; a tin box, the cover pierced with small holes; a few chip boxes.

Directions for dissecting Objects.—In dissecting minute insects, as the flea, louse, &c., in order to examine their internal structure, it is necessary to observe great care; they should be placed in a drop of water, and examined instantly, or the parts will shrink up. A delicate lancet, with a pair of the finest scissors and forceps, are generally used for such purposes.

Method of preparing and applying Objects for the Microscope.—Most objects require a little management in order to bring them properly before the glasses; if they are flat and transparent, put them between the talc in the slides—the scales of fishes, for instance, &c. In making your collection of objects, if you wish to fill a number of slides, care should be taken to arrange them as near the size of each other as possible in the same slider, in order that they may be examined by the same power. Minute living objects, such as mites in cheese, small insects on vegetables, &c., should be delicately brushed off into the object-box, and shut up; flies and small beetles may be held by the forceps.

To view the circulation of the blood, &c., in aquatic insects, place them in a small portion of water on a piece of flat glass; two pieces of glass may be made open enough to receive any sized objects of this kind, similar to the animalcule apparatus.

Method of viewing Animalcula in Fluids, with the greatest facility.—The great difficulty of viewing animacula in fluids must have been felt by all who use microscopes. A drop of water placed on a piece of glass forms a convex surface, and when a high power is used, the animalcula are continually getting out of the focus by diving to the bottom, and the drop very soon dries up.

The following contrivance effectually removes these obstacles when the focus of the power in use will admit one of the pieces of glass to intervene between the surface of the lens and the object. It consists of two pieces of glass fixed with a small portion of sealing-wax between them, and left open at the top. For viewing animalcula, these pieces should be pressed as close together as possible, but for larger insects they may be left more open. If a single drop of water is taken up by the small spoon at the end of the forceps, and spread over the orifice, it will run in between the two glasses, by which means the surface of the water is rendered perfectly even, and the animalcula are distributed more truly, and confined in a more limited space whereby their forms and movements are more discernible This plan also prevents evaporation from the surface, which often dims the lens and perplexes the observer; a single drop of water may be kept for hours in this way, with any curious animalcula alive in it. The glasses can be cleaned out by introducing a piece of thin writing paper between them, and a drop of pure water. By leaving sufficient room between the glasses, the larger aquatic insects may be viewed; such as small tadpoles, the ephemera, and the water flea. When animalcula and other minute objects are viewed with a lens of short focus, the following contrivance is simple and useful; upon a suitable piece of glass describe a circle with white paint; when dry, place the drop of water within the circle, and cover it with a very thin piece of talc, the space between the talc and the glass, produced by the paint, affords sufficient room for the animalcula to move, the talc (if sufficiently thin) offers no obstruction in bringing the object to the focus of the lens.

Slides for Transparent and Opaque Objects.—You will find clear slips preferable to talc in forming the slides for transparent objects; they may be prepared in the following manner: take two slips of glass about the size of the ivory slides; then get a piece of writing paper with holes of the same size; wet one side of the paper with gum water, and lay the glass upon it, suffering it to dry; then place your objects in the holes, wet the other side in the same manner, and lay on the other glass; any curious objects may be preserved in this way without danger of their perishing; talc may be applied, as in the preceding article, for deep powers.

Opaque Objects may be prepared for examination in the following way; cut a card or piece of stiff paper the size of the object to be examined; put a little gum water upon it, and the insect will adhere to it, and may be viewed by placing it under the microscope, on the stage; or, by means of the steel forceps, it may be held in the hand. For viewing minute opaque objects with a high power, with the body, a strong light must be condensed and thrown down upon them by means of a lens, but the single power or lens is better adapted for that purpose. A condenser can be applied to the microscope, by which means a greater power can be used with the body for viewing opaque objects. To preserve curious opaque objects, they may be fixed on some slips of glass with gum water, and another glass placed over them, cemented together with sealing-wax.

Active Molecules in Organic and Inorganic Bodies, discovered by Robert Brown, Esq., F.R.S., &c. &c.—This indefatigable gentleman, in prosecuting his elaborate researches into the vegetable kingdom, was led to infer (from circumstances connected with the investigation of the pollen plants suspended in water), that the same active molecules might likewise exist in inorganic bodies; he has not been disappointed, having succeeded in separating them from almost every known substance, such as minerals, glass, common dust, soot, &c. &c.; indeed the principal exceptions are oil, resin, wax, sulphur, such of the metals as could not be reduced to that minute state of division necessary for their separation, and finally, bodies soluble in water.

The process of obtaining a satisfactory view of these minute active molecules is exceedingly simple, and is as follows: with the head of a pin place a small drop of distilled or filtered water upon a slip of glass, then apply the head of the pin (again dipped in the water), to the substance from which the molecules are to be separated, which is effected by a slight friction; afterwards immerse the head of the pin in the water upon the slip of glass, gently agitating it; this will occasion the molecules to be transferred to the water upon the glass, which is then in a state to be submitted to the deep powers of the microscope; to separate the molecules from the glass itself, either pound it very fine, or gently rub together the unpolished edges of two pieces, having previously wetted them—the produce can then be transferred to a drop of water.

The figure of the molecules is spherical; they are so minute, that four hundred millions of them would not occupy greater space than a superficial square inch. Their motion is very vivid, and consists, not only of a change of place in the fluid, manifested by alterations in their relative positions, but also, not unfrequently, of a change of form in the particle itself; each molecule appears to revolve upon its axis: in fact, the whole of the motions are very similar to those of the most minute kind of animalcules inhabiting water.

Some persons have considered the motion to result from the evaporation of the fluid and the action of the breath of the observer upon its surface: this is proved not to be the case, by covering the water with a thin piece of talc, when the motions continue unaltered; it has likewise been urged that these spherical molecules may be hollow, and that the motion is produced by the water entering them, thereby displacing the air contained in them—were this the case the action must soon subside, which does not take place; besides, the molecules are proved to be suspended within the fluid, by bringing the surface to the true focus, when a variety of irregular particles (distinct from the molecules) will be discovered, evidently acted upon by exterior causes.

When it is considered that there is not the slightest difference in the general figure of these active molecules (let the substance be what it may from which they are separated), it will be conceded that their identity gives them a character which makes it difficult to prove their figure and motions to be the result of mere chance, exterior mechanical causes, or optical delusion.

Infusoria, or Animalcula in Vegetable Infusions.—The smallest living creatures we are acquainted with are the animalcula in fluids; they afford a wonderful scope for inquiry, and nothing is more capable of affording instruction combined with amusement, than researches into the secrets of nature in the more minute parts of her works, and they present to view most surprising wonders hitherto unknown; for who would or could have imagined that, in a single drop of water, thousands of living creatures are found, most of them invisible to the naked eye, and so extremely minute, that many thousands of them will not cover the space of a grain of sand; the littleness into which nature descends in these productions, nevertheless, offers one of the most agreeable subjects for instruction and admiration; for by comparing one of these minute living creatures with a larger animal, whose appearance is terrific, what a disproportion is observable, and what efforts of the imagination does it not require to conceive the smallness of the parts of this minute living creature, for it will appear they are furnished with as many or more members than the largest animal! They possess the apparatus necessary for the circulation not only of the blood, but the atmosphere through their bodies, and the patient experiments of Professor Ehrenberg, of Berlin, have proved, that these exceedingly minute and interesting animals, to whom naturalists (the great Cuvier not excepted) had hitherto denied the possession of any chemifying apparatus whatever, asserting that they were nourished and sustained by imbibition or absorption, through their entire surface, have no less than from four to forty sacs or stomachs. The mode of verifying this fact is extremely simple, and consists in the following process: a drop of water containing animalcula is to be placed on a slip of glass, and a small quantity of solution of vegetable coloring matter added to it with a camel-hair pencil, the creatures will feed on this substance, and consequently distend their stomachs. Another drop of clear water must now be placed near the first, and by drawing a fine point from one to the other, the animalcula from the colored drop will escape into the clear drop, where they may be examined with facility, and the color of the food will enable the observer to count the stomachs. If the experiment be repeated with another color, the creatures will feed again, and other stomachs will be filled in like manner. Care should be taken that the coloring be purely vegetable, for if it contain any mineral particles, the animalcula will die, or at least instantly reject the food, so that the experiment will fail. Indigo, carmine, sap-green, are found to answer best; in a word, this little world contains objects of the number and variety of which we cannot have *the smallest* idea without the assistance of the microscope.

Equivocal or Spontaneous Generation.—Equivocal or spontaneous generation, that is, the production of plants without seeds, and of living creatures without any other parents but accident and putrefaction; such was the absurd opinion that prevailed of the production of the minute living creatures, before the microscope overturned it, by demonstrating, that all plants have their seeds, and all animals their eggs, whence the same species are produced. Nothing seems more contrary to reason, than to suppose that chance should give being to regularity and beauty, or that it should create living animals, fabricate a brain, nerves, and all the parts of life; and, as Mr. Baker observes, we may as well suppose that the woods generate stags and other animals that inhabit them, as that a cheese generates mites without the egg. The growth of animals and vegetables seems to be nothing more than a gradual unfolding their parts till they obtain their full size. Though water, by merely standing a few days, will be found to contain them, yet they will not be found in any degree so numerous as when vegetable bodies have been steeped therein, for no living creatures seem to subsist upon water alone; but when it is stored with their proper food, myriads may be found in every drop, of the greatest variety in their forms: some are round, some oblong, and others spherical, and the greatest part of them transparent: motion seems to be their greatest delight; they pervade with ease and the greatest rapidity the whole dimensions cf the drop of water, in which they find ample space; sometimes they dart forwards, and at others more obliquely; then again in a circle, and though hundreds may be seen in a single drop, yet they never strike against one another. They differ in their size; some are barely visible to the eye: some so minute as to resist the action of the microscope, and appear only as moving points; of this description is the monus; it is so extremely delicate and transparent, as sometimes to elude the highest magnifying power: some are, no doubt, inhabitants of the water, and others turn into small flies, and deposit their eggs in any kind of fluid producing proper nourishment for their young; the eggs being hatched, they live a certain time in this element, then take wing after a complete change in their forms. This may often be observed, for when they grow to a certain size, of a sudden you will find them gone, and a small race supply their place. *As these infusions, to* produce them, are all prepared in a similar manner, and as the two following substances may be procured without much trouble, and generate the most remarkable subjects, we shall describe the necessary preparations.

Hay.—The infusion of hay produces the greatest variety of animalcula, and by far the most curious. Twist up a little hay, and press it down into a tea-cup, or any other vessel; cover it with water to the top, and if it absorbs the water, put fresh in; in a few days, in summer, a scum will appear on the top; take from the surface, with the spoon at the end of the forceps, a single drop, and place it between the glasses; it will be found to contain extremely minute animalcula; in a few days they increase in size, and in about ten days they obtain their full growth. It is impossible to enumerate the variety that may be discovered at different times in this infusion; the most numerous are in the shape of an egg; and with a high power a great number of small feet may be discovered, and at the head a number of fibrillæ, which are continually in motion, creating a vortex in the water which brings their prey towards them, which may be discerned many hundred times less than themselves; they use their legs in running as well as in swimming, for by placing a human hair across the water, a number of them will be seen running along it. We shall find another sort in the shape of a sole, without the appearance of any legs, and many others which are described in the following pages. The eggs or spawn may be seen, with a high power, attached to any small portion of matter in the drop of water.

Pepper.—Put common black pepper, bruised, into an open vessel, enough to cover the bottom; pour water upon it about an inch deep, stir them together when first mixed, and afterwards let them remain still. In a few days, in warm weather, a scum will appear on the top; take a single drop from the surface, and place it on the glass. It sometimes happens, that such multitudes are in a single drop, that it becomes quite opaque; in this case, dilute it with a drop of pure water.

The following substances produce different descriptions of *animalcula*; senna, Indian wheat, cabbage, raspberry-stalks, *all kinds of* flowers, grasses, &c.; oatmeal, bran, &c.; also water in which flowers have been standing for any length of time.

Bell-shaped Polype.—During all the months in summer, a great abundance of these curious insects is to be found on the shells of the small water-snail, duck-weed, and other water-plants, and on the larvæ of the larger insects, in such multitudes, at times, as to appear like a fine down upon them ; they are extremely minute, and generally fasten themselves by their tails in groups of twenty or more, extending themselves in every direction in search of food.

Paste Eels.—Those who are desirous to be furnished with a curious living object for the microscope, should be provided with the eels in paste; they are, after the paste has been made for some weeks, so numerous that the whole surface of it appears alive, and by taking from the surface with a point of a needle the smallest particle, and putting it in a drop of water, it will be found to contain a number of these minute eels, with a continual regular motion swimming about the drop of water.

Vinegar Eels.—A small eel may likewise be found in the dregs of vinegar, that moves much quicker than the above.

Eels in Blighted Wheat.—These animalcula are not usually lodged in such blighted grains of wheat as are covered externally with soot-like dust; but abundance of ears may be observed in some fields having grains that appear blackish, as if scorched, and, when opened, are found to contain a soft white substance. This, examined attentively, seems to be nothing else but a knot of threads lying as close as possible to each other. This fibrous matter exhibits no sign of life, but, upon applying water to it, the supposed fibres separate, and prove to be living creatures by motion, at first languid, but gradually more vigorous.

Butterflies and Moths.—We cannot enumerate all the different sorts of these beautiful insects, and it is impossible to describe the variety and splendor of their plumages, surpassing all the magnificence of the richest and most costly dress. All the butterfly and moth tribes are bred from caterpillars. The number of these insects is very great;

Linnæus reckoned eight or nine hundred different kinds, some of which are extremely rare, and only found in particular places. The legs, antennæ, the eyes, in fact every part, when examined, afford the highest entertainment.

Dust on the Feathers of a Butterfly's Wing.—The wings in themselves are, like the common fly's, transparent, but owe their opacity to the beautiful minute feathers which cover them; and, examined by the microscope, nothing can exceed the beautiful and regular arrangement of these little substances, which, by their different colors, serve to paint the wing, and by their regular layers, resemble the tiles of a house-top. Carefully brush some of the dust off on your slide, between two pieces of talc, place it under the microscope, and you will be richly rewarded for the trouble taken. With a high power and strong light, beautifully prismatic colors and lines may be discovered.

Caterpillars.—The caterpillar is one state of the butterfly. If the silk-worm be observed in every stage, from the caterpillar to the moth, it will give a correct notion of this class in general.

The body consists of twelve rings, and the changing its skin is effected by its withdrawing from the old one as from a sheath; and to accomplish which seems to be the work of time, but which they do successively three times before they arrive at their perfect state. The skins which they shed may be viewed by the microscope to much greater advantage than the real insect, and are well worth procuring; one in particular, having four tufts of yellow hairs, and covered with smaller ones. These, when examined, appear like feathers.

Insects on the Bark and Leaves of the Ash.—On the bark and leaves of the ash and other trees a small insect is found, enclosed in a dark spot, not larger than a pin's head; each spot serves as a covering for thirty or forty ova; which, on removing a fine silken covering, may be seen of a scarlet color, but extremely minute; and it is pleasing to see them creep out of their cases.

The Flea.—This well-known insect is covered all over with a shining armor, or scale, curiously jointed, and folding one over the other, with long spikes in regular order; its neck is finely arched; it has two large black eyes, and a pair of horns, or feelers. Its head is very extraordinary; from the front part proceed two legs, and between them is its sucker, or piercer, by which it penetrates the skin of animals, and draws out the blood. It has also four other legs, and when it takes its amazing leaps, it folds the short one within the others, and exerting its spring at the same time, carries itself to a great distance for so small a creature.

The Common Fly becomes an interesting object by dissecting it, and placing the different parts under the microscope, particularly the foot; the body is covered with long hair, the head contains two large eyes, and is one of the most curious objects under the microscope that can be conceived, for it is found to contain a number of lenses, or eyes, and, like the spider, it cannot move its head; the trunk consists of two parts, sheathed in the mouth. It deposits its eggs in any kind of flesh; these are generally called fly-blows, but if examined will be found perfect eggs; from the eggs proceed minute worms, or maggots, which in a few days become flies.

The Clothes Moth.—Many are not aware to what extent of mischief this little creature is capable: all kinds of fine woollens, furs, and feathers, if not entirely destroyed, are rendered perfectly useless in a short time, by this diminutive enemy. The perfect insect is a small moth, not so large as the common fly, of a pearly appearance, which may often be observed to fly out on opening the doors of wardrobes, boxes, drawers, &c. In the summer months they deposit their eggs in woollen substances, where they in a short time become small caterpillars, and immediately begin their work of destruction; they creep into the folds of the cloth, and remain undetected till the cloth is held up to the light, when it is found as full of holes as if it had been perforated with shot.

Mouldiness.—All kinds of mouldiness on decayed fruit, bread, &c., the microscope discovers to be exceedingly minute plants, bearing leaves, and, in every respect, developing the same beauty and regularity as the leaves of the trees, &c.

Mites, &c., in Seeds.—Various species of mites, and other curious insects, may be found in the siftings of seeds, particularly a very peculiar one, in those of the common poppy; this insect is furnished with two fangs of a very formidable description, having joints like the claw of a lobster—with these fangs it seizes its prey and conveys it to its mouth. I would recommend every person possessing a microscope to provide himself with some of these siftings, which may be procured at any of the seed shops.

Cheese Mites are those minute creatures found in old cheese. To the eye they appear like moving particles of dust, but the microscope discovers them to be animals, perfect in all their parts, having as regular a figure, and performing all the functions of life as well as those animals which are many million times their size.

Common Salt, &c.—Place a single drop of water in a glass, and put a few particles of common salt in it; give it a gentle heat till the water is evaporated, and you will have beautiful crystals, in the form of cubes, Epsom salts in six-sided prisms, alum in octagons, crystals of nitre, saltpetre, and green vitriol. To obtain crystals of camphor, place a drop of spirits of wine on a glass, hold it over a candle; when evaporated, place it on the microscope, and they will be seen.

Microscopic Chemistry.—Another important field of inquiry by the microscope is chemical action. This opens an endless subject of investigation of a very rich order; and will probably lead, ere long, in the hands of some talented experimenter, to very valuable results. The mode of pursuing this class of observations is very simple. Prepare a few pieces of thin and very flat glass, about an inch long and three quarters of an inch broad. They may be larger or smaller, according as is best adapted to the port-object of the microscope to be used. Some of them should be the eighth of an inch less every way than the others. A variety of chemical agents should be provided in small glass bottles with glass stoppers, and a few glass rods about four inches long, with a rounded end, for the purpose of taking a small drop out of any liquid. These should be kept in a glass of clear water, when they are not actually used, in order that they may be free from any particles of an extraneous substance. In experimenting, at the outset adapt the focus of the microscope to one of these glass plates. Then, upon one of the larger plates of glass, spread thinly any precipitate or other chemical agent with which you wish to work. Lay the glass upon the port-object, and examine leisurely the character and form of the substance. Then, upon one of the smaller glasses, lay, with a glass rod, a small drop of any acid or other fluid with which you wish to act; and having spread it on the glass, lower it down nearly upon the other glass, so that the edges of the upper glass shall not reach beyond the under one; as the upper glass, when once brought in contact, should never be disturbed. The two substances will thus, by pressure, be reduced to one uniformly thin film; and the action which takes place may be very accurately investigated.

For instance, let the first glass receive a very minute portion of the carbonate of copper, and the upper glass a drop of nitric acid; on contact, the carbonic acid of the carbonate will be seen coming away in globules, whilst the carbonate of copper breaks down and disappears. The field is gradually occupied with a solution of nitrate of copper; and this is seen to crystallize in minute rhombic crystals. Lift up the upper glass, and add a small drop of ammonia, and slip down the glass again; the crystals of the nitrate disappear; a new combination takes place, and you see the beautiful foliations of the nitrate of ammonia interspersed with groups of the still more beautiful prisms of the deep blue ammoniuret of copper. Or, instead of the ammonia, add muriatic acid; the nitrate is changed into a grass green solution of the muriate of copper, which crystallizes in bundles of spears shooting in all directions across the field of vision.

These phenomena may be multiplied to any extent by the use of the numerous chemical agents to be obtained. Iodine presents an endless variety of aspects in combination with different agents. The crystallization of hydriodate of potass is very beautiful, if a drop of the solution is put on a glass. Put on the other glass sulphuric acid. When brought in contact, the acid takes the potass, and forms crystals of the sulphate of potass, and the iodine is developed both in solution, which passes off by evaporation, and in the crystalline form of the substance itself. Again;

combine solution of iodine with solution of sulphate of soda. The alcohol in the solution of iodine takes part of the water from the soda, and the rest of the sulphate of soda immediately crystallizes in prisms. The iodine, deprived of the alcohol, is developed in cherry red drops of liquid and in dark rhombic crystalls. In fact, in the endless variety of objects that can thus be brought before the eye, both the young student and the scientific chemist will find at once a means of amusement and of deep analytic investigation of the most fascinating and important kind. Evaporation or boiling may be carried on in the same way by extending one end of the glass over the port-object, and placing underneath it a small spirit-lamp, so that even the changes incident to this state may also be examined. The observations made by examining the effect of chemical agents on the juices of plants, offer a subject of very great interest and importance.

But the examination of chemical action may be carried still further by the application of the galvanic battery under the microscope. A small battery of thirty plates, two inches square, is sufficient for the purpose. Place any chemical agent, as liquor potassæ, on one glass plate; use a low power in the microscope to prevent vapor gathering on the lens, owing to its nearness; and then guide the two wires near to each other in the drop of liquid. The oxygen will go to one pole, and the potassium to the other. The dendritic foliations that form at one pole and grow out towards the other, in ammonia and nitrate of silver and other agents, are very beautiful. The effect visible in albumen, the white of egg, is very interesting. It has long been observed that albumen coagulated on the application of galvanic power; the microscope shows quite distinctly what this coagulation is. Albumen is a vesicular structure. The action of galvanism is to burst these vesicles, and draw out the liquid contained in them to one pole, while the vesicles all shrink up towards the other; and their approximation gives the character of whiteness and solidity that appears. The arrangement of these vesicles, and the nerves or bands along which the cellules are arranged, are easily distinguished beyond the possibility of mistake.

To these observations may be added, the examination of various crystallizations in polarized light. Between the reflecting mirror and the port-object insert a plate of tourmaline, so that the condensed light of the mirror be thrown upon the object through the tourmaline. This polarizes the light received. Then, above the eye-piece, lay another plate of tourmaline. This serves as the analysing plate for perceiving the changes produced by the polarized light. Many crystals so observed, as sulphate of potass, &c., exhibit the most beautiful coloring, according as the upper plate of tourmaline is turned round on its axis. Some crystals, as nitrate of potass, exhibit these colors without the upper or analysing plate. The lamina of the crystal itself, as is the case with the mineral called iolite or dichroite, serve to polarize the light passing through it, and to make it visible. Instead of the upper plate of tourmaline, an analysing prism of Iceland spar may be used, which exhibits these colors of polarized light with still greater softness and perfection.

Now, simple as are these means of observation, so presented to our notice, they will serve very widely to extend our range of philosophical inquiry. The small port-object of the microscope becomes a very effective chemical laboratory, where phenomena connected with chemical action may be examined with an accuracy quite impracticable in larger masses; and for the purpose of analysing unknown substances, innumerable experiments may be carried on in a short time where the quantities are comparatively insignificant. A door is thus opened into the arcana of nature, which the man of truly scientific mind has only to enter, and he will be gratified by an intimate observation of phenomena, connected even with results which are, on the great scale, quite familiar to him, that he will view with unfeigned surprise. A microscopic acquaintance with the minute aspect of chemical changes will bring him into nearer intimacy with substances that he has long known, and guide him to conclusions which have hitherto only worn the dark character of conjecture.

A few other similar experiments may be mentioned.

1. Add sulphuric acid to common salt or muriate of soda; or to carbonate of ammonia.

2. Add sulphuric acid to bichromate of potass or muriate of soda. The result is crystals of sulphate of soda and potass, with chloro-chromic acid.

3. Add acetic acid to bichromate of potass. The crystallization of the bichromate takes place in very beautiful forms.

4. Add sulphate of alumina and potass to muriate of cobalt. The crystals of the alum form in great perfection.

5. Add acetic acid to nitrate of copper. The biperacetate of copper forms slowly, and crystallizes in great beauty.

6. Add terrocyanate of potass to sulphate of iron.

7. Add nitrate of potass or aqua potassæ to sulphuric acid. The sulphate of potass forms in solution. Raise the upper glass with a knife the smallest degree, and let it fall again; the crystallization is instant.

8. The smallest drop of any liquid containing lead may be examined by the usual tests for lead; and wine may, in the same way, be tested in a drop not bigger than a pin's point.

9. The bin-iodide of mercury is a beautiful crystal, and open to a variety of experiments.

10. Investigate the comparative purity of successive crystallizations of nitrate of potass.

In fact, every combination or decomposition which can be effected in the retort, may be carried on as easily on the port-object of the microscope, and the action more accurately observed than in any other way. A little of the manual facility and ocular keenness which are acquired by practice being all that is needful; and this is speedily attained.

The Works of Art and Nature compared together.—Upon examining the edge of a very sharp razor, it will appear as broad as the back of a knife, and full of notches. The point of a small needle, though extremely fine to the naked eye, will appear through the microscope full of holes and scratches; but the sting of a bee, viewed with the same, will appear beautiful, without a flaw or blemish. A piece of fine muslin or lawn appears like a coarse lattice, and the threads like ropes; the same with fine lace; but the thread of a silk-worm, or the web of a spider, will appear perfectly smooth. The smallest dot made with a pen appears a vast irregular spot, rough and jagged. Thus sink the works of art; but in those of nature, even in her meanest productions, nothing will be found but beauty and perfection.

What we know at present of things near and familiar is so little, that there remains a boundless space for our inquiries and discoveries in the works of nature, and the more we inquire into them, the more comprehensive and just will be our ideas of the power, wisdom, and goodness of the Deity.

A List of the Principal Objects which afford the highest entertainment and instruction by the Microscope.

Animalculæ of all kinds, particularly interesting.
Ants' heads, legs, wings, and eggs, proper subjects.
Anise-seeds, curious, when seen through a microscope.
Ash-branches, cut transversely.
Apricot-skin, cut very thin, downy side upwards.

Bees, sting of, a pretty object when magnified.
Birds' small feathers, down, vermin, seed, &c.
Blessed thistle seeds, an interesting object.
Bread, when mouldy, appears like a forest.
Blood, human, and of animals, full of transparent globules.
Bones, burnt, or shaved off nicely, very curious.
Briar leaves, a particularly interesting object.
Bugs, the coat, head, &c., of very small ones.
Bloom on plums and grapes, nothing but animalculæ.
Beans cut in thin slices transversely.
Butterflies, every part wonderful and delightful.
Beetles of every description, their wings, legs, &c.
Beard of wheat, rye, barley, &c.

Cod-fish, milt of—Claws of insects.
Crystals of salt—Corals, small pieces of.
Cork, small shavings of, numberless cells therein.
Circulation of the blood to be seen in the limbs of small crabs.
Circulation of the blood in the tails of shrimps and legs of small spiders.
Circulation of the blood in the wings of grasshoppers.
Crickets' legs, feelers, skin, &c.—Centipedes' legs.
Cherries, skin of the fruit—Currants, skin of.
Cotton, small pieces of.
Chemical preparations, colored fluids, very interesting.
Crystallized cinnabar.
Copper ore.

Dandelion, seeds and down of, exquisite.
Decayed fruits, very interesting subjects.
Damp mouldy leather, resembles a thicket of trees.
Down of feathers, and skin, very beautiful.

Down of peaches, and quinces, and other fruits.
Down of bean shells and lupin shells.
Derbyshire spar, very small pieces of.
Diamond dust, and the dust of other precious stones.
Deal, small shavings of.

Earwigs' claws, wings, legs, and the insects that infest them.
Eels, in paste and sour vinegar, very curious.
Elm, root of.

Fruits, rind of. pared very thin.
Fleas, very small ones.
Flies' heads, wings, legs, feelers, &c. very proper.
Farina of flowers and plants, also of butterflies.
Flakes of snow—Frost-hoar from windows, &c.
Flint and steel, small particles from the collision.
Flour, mites in.—Fur of animals.
Feathers of small birds, downy part very curious.
Fish, the tails and fins of very small ones, stickleback, &c.
Fish skin, and fibres of crabs resemble fine linen.
Fishes' eyes, teeth, brain, gills, and transparent shells.
Flowers, thin leaves of, very interesting.
Flowers of grasses, corn and fruits.

Gooseberries, thorns and skin of.
Gnats' heads, wings, and legs, very beautiful.
Grasshoppers' head, legs, and various parts of the body.
Glow-worm, under part very beautiful.
Garnet sand.

Hairs of the head, of hogs, cats, mice, and other animals.
Hairs of plants, fruits, leaves, seeds, &c.
Hail-stones.
Hornet's Wings, skin, sting, &c.

Ice-plants, very beautiful.
Ice, small pieces of.
Insects of all kinds, if small, proper objects.
Insects' eggs, nests, &c.

Lizards, very small ones, all parts proper objects.
Limbs of small shrimps, and aquatic animals.
Lemon, the peel sliced very thin, and fruit cut transversely.

Lawn, fine, when magnified, like coarse lattice work.
Ladybird's wings, head, and feelers, very fine.
Lice, animal and vegetable, good objects.
Linen, very fine, small pieces of ditto.
Lead, sulphuret of.

Mites in cheese, and mites in flour.
Mosses of all kinds, very curious, also moss-seed.
Mould on bread, paste, leather, casks, &c., good.
Milt of cod and other fishes.
Mandibles of insects, very curious.
Mushrooms, truffles, puff-balls, funguses, &c.

Nettles, stings of, very interesting objects.
Nectarine, the downy skin, cut very thin.
Needle antimony.
Native gold.

Orange peel, extreme thin slices.
Ditto, the fine skin of the sections.
Ditto, the fruit cut transversely very thin.
Oyster, the clear liquor of, very curious.

Paste when sour, variety of eels to be found in.
Prince's-feather seeds, divided.
Puff-balls, thin coat of, also the powder from.
Plants, all transparent ones.
Parsley seeds, very curiously ribbed.
Plantain, and all small seeds divided.
Pears and apples, cut transversely or longitudinally.
Peaches, plums, and other wall fruit, skin cut thin.
Palm leaf.

Rose flower, and bush leaf, very beautiful.
Rind of most fruits and vegetables, cut thin.
Razor, edge of the sharpest, when magnified, full of notches.
Ribbon, small pieces of.

Sponges of all sorts—Salts, crystals of.
Sweet-briar leaves, very interesting.
Sage leaves, resemble a coarse rug or carpet.
Sand, small particles of, very pretty.

Spiders' heads, legs, claws, eggs, webs, and the insects that
infest them.
Silkworms, webs, and all parts of their body, curious.
Stings of insects, very interesting objects.
Spiral proboscis of the butterfly, ditto.
Strawberries, outward skin of, very interesting objects.
Skin of the human body, very thin slices of, ditto.
Silk, small pieces of.—Steel filings, ditto.
Silver, native.
Skin of a melon.

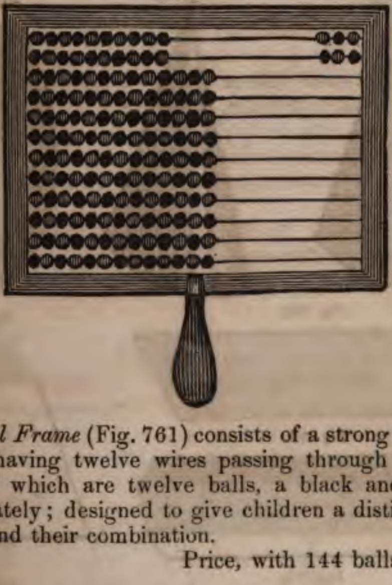
Thorns from sweet briar, or rose bushes.
Thistles, the down and seeds of small ones.
Trees, bark of, and rind of young branches.
Trasparent stones, pebbles, agates, &c.

Vinegar, stale, animalcula to be seen in.
Veined woods, fine shavings of, very curious.

Wings of all small insects, very pretty and proper.
Water stagnant, abounds with animalcula.
White poppy seeds, whole or divided.
Wheat, tuft on the embryo grain, beautiful.
Worm-wood, cut transversely, ditto.
Wasps, every part of, truly interesting.
Wood lice, legs of, &c.—Worms of all kinds.
Water insects, very interesting objects.
Webs of spiders, silkworms, &c.
Wood, very thin shavings of.
Walnut, root of.

MISCELLANEOUS INSTRUMENTS.

Fig. 761.



Numeral Frame (Fig. 761) consists of a strong frame with a handle, having twelve wires passing through the frame, on each of which are twelve balls, a black and a yellow one alternately; designed to give children a distinct idea of numbers and their combination.

Price, with 144 balls, 88 cts.

Geometrical Solids.—(Figs. 762 to 773, next page.)—This apparatus consists of a set of twelve solids by which the fundamental principles of geometry may be illustrated; important in the course of education for giving a clear idea of the science. They consist of—1, a cylinder; 2, oblique cylinder; 3, triangular prism; 4, six sided prism; 5, sphere; 6, oblate spheroid; 7, prolate spheroid; 8, hemisphere; 9, cone; 10, pyramid; 11, frustum of a cone; 12, frustum of a pyramid.

Price, the set, $1.25.

Fig. 762.

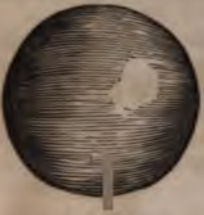


Fig. 763.

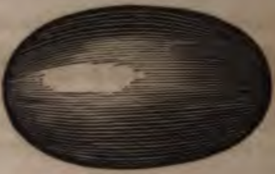


Fig. 764.

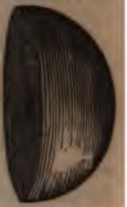


Fig. 765.

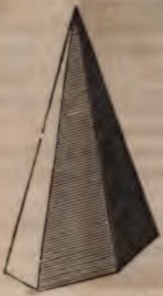


Fig. 766.

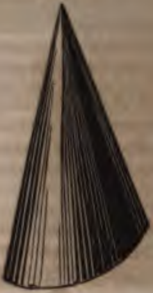


Fig. 767.

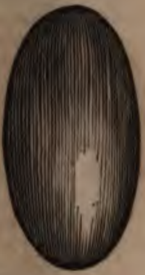


Fig. 768.

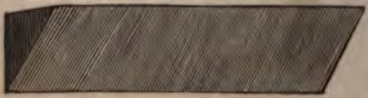


Fig. 769.

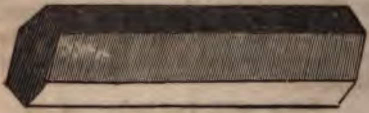


Fig. 770.

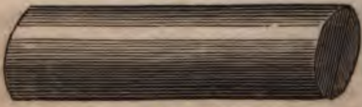


Fig. 771.

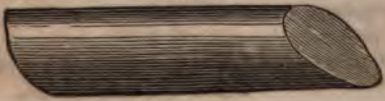


Fig. 772.

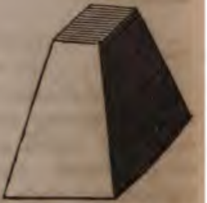


Fig. 773.

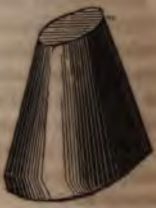
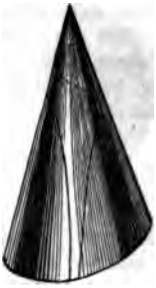


Fig. 744.



Dissected Cone.—(Fig. 774.)—The dissected cone is used for illustrating the conic sections. It is formed of a cone of hard wood cut in parts representing these sections, as the ellipse, parabola, hyperbola, which may be put together by short pins in the parts forming the complete cone.

Price, $1.25.

Hearing Trumpet, or Ear Trumpet.—(Figs. 775 to 779.)—The hearing, or ear trumpet, is for the purpose of collecting the rays of sound by reflection, and conveying them to the ear. It may be considered as a reversed speaking trumpet, with which it generally corresponds in form, though, for the sake of portability it is often curved; they are also recommended of a parabolic figure having the apex of the paraboloid cut off, and the mouth of a small tube inserted in the focus, to convey the sound concentrated at that point to the auditory organ. Various other forms are adopted in practice; and of late, flexible India rubber tubes *formed over a spiral* wire (Fig. 780) have been brought into

Fig. 775.

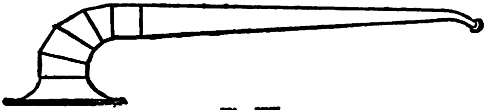


Fig. 776.

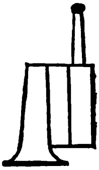


Fig. 777.

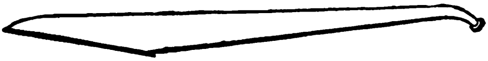


Fig. 778.

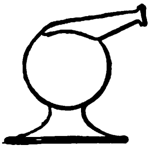


Fig. 779.

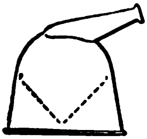
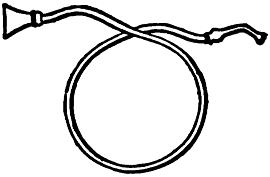


Fig. 780.



use, having a conical mouth-piece of ivory, horn, or metal, at one extremity, and a small tube of like material, to be applied to the ear. A trumpet of this kind may be used advantageously, not only for remedying the defects of hearing, but for assisting the observer to collect feeble and distant sounds. Price, Figs. 775, 776, 778, 779, $1.25.
" Fig. 777, - - $1.00.
" Fig. 780, - - $2.25.

Breast Pump and Cupping Pump.—An apparatus for effectually drawing the breast is represented in Fig. 781; it consists of a globular glass with an open bottom made of the form of the breast, having a small neck with a brass cap and valve opening outwards, to which is attached by a screw, a small air pump, by which the air is rarified, and the milk in consequence flows out. To use, hold the instrument upon the breast with one hand, observing that the end of the small pipe is turned upwards, and the small hole in the brass cap covered with the thumb; then work the handle until the milk begins to flow, and continue occasionally to pump until the glass is sufficiently full, when by removing the thumb from the hole the glass will come off.

Fig. 781.

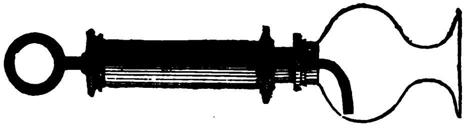
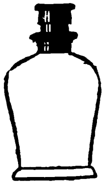


Fig. 782.



For Cupping the same pump is used, with a glass or glasses of a form represented in the cut (Fig. 782). For dry cupping, where it is required to produce a greater flow of blood to a particular part, than is usual, the manner of using is the same as the breast pump; the glass being placed upon the part to be affected and the handle worked; the blood is thus urged into the small arteries and veins, so as to produce a considerable redness under the cupping glass, at which place the skin is also much elevated and rather inflamed. When blood is to be drawn the glass is first used and the scarificator applied immediately after its removal; the glass being fixed again on the same spot and left there ll the blood has flowed freely. Several glasses and scari-ators are frequently used at the same time.

The Scarificator is an instrument in which some sixteen twenty lancets are placed, and when applied to the rt, the whole number of lancets contained in it are by eans of a strong spring pushed suddenly into the part to cupped, to the depth at which the instrument had been reviously regulated.

Price, breast pump in neat case lined with velvet, - - - -	$ 5.00.
" brass pump and three cupping glasses,	$ 9.00.
" " " and scarificator,	$14.00.

PARTICULARS

OF A SET OF

PHILOSOPHICAL APPARATUS

FOR $50.

Fig. 117, five inch terrestrial globe, $1.25; Figs. 762 to 773, set of twelve geometrical solids, $1.25; Fig. 761, numeral frame, 88c. $3.38.

Optics.—Prism, 38c.; Fig. 699, color blender, $1; kaleidoscope, 12c.; multiplying glass, 38c.; magic lantern and set of twelve sliders, $1.25; concave and convex mirrors, four inch diameter, $1.25; Fig. 746, microscope, $1; concave and convex lenses, 50c. $5.88.

Pneumatics.—Fig. 182, single barrel air pump and receiver, $7; 191, hand and bladder glass, 75c.; 211, air shower, 75c.; 195, pressure glass, 75c.; 197, Magdeburgh hemispheres, $4; 248, syphon, 38c. $13.62.

Electricity.—Fig. 286, nine inch plate electrical machine, $6.50; 276, Leyden jar, 75c.; discharger, 25c.; 297, electrical bells, $1.25; 300, pair of image plates and pith images, $1.25; 305, long hair man, 75c.; 320, swan, 50c.; 313, revolving flyers, 50c. $11.75.

Galvanism and Magnetism.—Fig. 391, galvanic battery, $2.50; 424, electro-magnet, $1; 426, magic circle, $1; 410, horse-shoe magnet, 50c.; iron rods and filings, 25c.; magnetic needle, 38c.; magnetic fish, 25c. $5.88.

Chemistry.—Fig. 484, two glass retorts, 56c.; 483, one matrass, 25c.; 482, two flasks, 12c.; 514, retort stand, $1.25; 511, spirit lamp, 75c.; 481, one bell glass receiver, 50c.; one stoppered glass jar, 38c.; 525, one bell glass receiver with cap and stop-cock, $1.75; pipe, jet, and gas-bag, 88c.; 508, blow-pipe, 38c.; 509, nest of crucibles, 6c.; 512, mortar, 50c.; 504, air thermometer, 12c.; 494, funnel, 15c.; 502, two test tubes, 10c.; 237, scales and weights, $1.75; 238, hydrometer, 50c. $10.50.

APPROVED SET OF

PHILOSOPHICAL APPARATUS

FOR THE SUM OF $150.

Fig. 150, set of five boxwood balls for collision, $1 ; 145, pair of glass plates for attraction of cohesion, $1.50 ; 148, set of tubes for capillary attraction, 50c. ; 123, planetarium, $7.50. $10.50.

Optics.—Fig. 731, magic lantern and 12 comic sliders, $8 ; 751, compound microscope, $4 ; 702, camera obscura ; $3.50 ; 698, prism, $1 ; 699, color blender, $1 ; kaleidoscope, 50c. ; set of lenses, 1⅜ inch diameter, $1.25 ; concave and convex mirror, 5 in. diameter, $2.25 ; multiplying glass, 50c. $22.00.

Electricity.—Fig. 272, electrical machine, with 6 inch cylinder, with knob, two chains, and box of amalgam, $12 : 276, Leyden jar, $1.25 ; 277, discharger, $1.25 ; 296, bells, $2.00 ; 300, pair of image plates and pith images, $1.25 ; 302, one dozen pith balls, 25c. ; 305, long hair man, 75c. ; 315, horsemen, $2.50 ; 320, swan, 50c. ; 322, syphon and bucket, $1 ; 335, luminous spiral tube, $2. $24.75.

Pneumatics.—Fig. 183, single-barrel air-pump, with bell-receiver, $12 ; 191, hand and bladder-glass combined, 75c. ; 211, air shower, 75c. ; 212, mercury cup, 75c. ; 195, pressure glass, 75c. ; 197, Magdeburgh hemispheres, $4 ; 200, fountain, $4 ; 206, bladder and weights, $1.75 ; 218, bell, $2.25. $27.00.

Hydrostatics, &c.—Fig. 248, syphon, 75c. ; 102, spirit level, $1 ; 238, hydrometer, 75c. ; 259, hydrostatic bellows, $5 ; 252, lifting pump, $3. $10.50.

Galvanism and Magnetism.—Fig. 400, Grove's battery, with apparatus for the decomposition of water, charcoal points, &c., $12 ; 391, pot battery, $2.50 ; 424, electro-magnet, $1.50 ; 426, magic circle, $1.75 ; 407, powder cup, 75c.; 469, magneto-electric machine for shocks and sparks, $9.50; 410, magnet, 75c.; 418, star plate, 50c.; 6 inch magnetic needle with mariner's card, $1. $30.25.

Chemistry.—Fig. 514, retort stand, $1.50; 511, spirit lamp, 75c.; 482, three flasks, 25c.; 484, three assorted retorts, $1; 489, one receiver, 38c.; 483, one matrass, 38c.; 522, pneumatic cistern, $2; 481, two bell glasses, quart and half-gallon, $1.25; stoppered gas bottle, half-gallon, 63c.; 525, bell glass, with cap, stop-cock, jet, pipe, and gas bag, $2.75; 540, gas pistol, 39c.; 508, blowpipe, 38c.; 500, dropping tube, 38c.; 494, funnel, 15c.; 512, mortar 75c.; 507, evaporating dish, 38c.; 509, nest of crucibles, 10c.; 495 grade measure, 63c.; 237, scales and weights, $1.25; 493, two precipitating glasses, 31c.; 502, three test tubes, 15c.; 504, air thermometer, 19c.; Torricellian tube, 75c.; 555, pyrometer, $3.50; 552, conductometer, $1.75; 556, condenser, $1; 542, eolopile, 38c.; 543, boiling glass, 50c.; 560, Wollaston's steam apparatus, $1.50; 540, hydrogen gas pistol, 38c. $25.59.

Total, $150.00.

Or, with the addition of the following, $250.

Figs. 154, 155, 156, and 158, set of mechanic powers, $16; 147, four and a half inch surveyor's compass, $14; 180, double barrel air pump, in place of single barrel air pump, $22,50; 208, piston weight lifter, $6; 260, vessel for spouting fluids, $4; 267 or 270, plate electrical machine, in place of cylinder electrical machine, $25; 536, compound blow pipe and pneumatic cistern combined, in place of pneumatic cistern, $8; 733 and 740, superior magic lantern and set of astronomical sliders in place of magic lantern and comic sliders, $35; 604, barometer, $10.

APPROVED SET OF
PHILOSOPHICAL APPARATUS
FOR $600.

Fig. 144, inertia apparatus, $1.50; 145, pair of plates for attraction of cohesion, $1.50; 148, set of tubes for capillary attraction, $1; 150, set of five ivory balls for collision, $1.25; 153, 154, 155, 156, 157, set of mechanical powers, $35; 123, planetarium, $7.50; tellurium, $6.50; 95, quadrant, $15: 92, surveyors' compass, $20; two pole surveyors' chain, $1.25. $90.50.

Optics.—Fig. 698, large prism, $1.50; 699, apparatus for the recomposition of light, $1; set of four lenses, two and a half inches diameter, $6; multiplying glass, 50c.; 694, 695, 696, 697, set of four eye models, $13; 702, camera obscura, $3.50; 701, cosmorama and twelve views, $4.25; pair of six inch mirrors concave and convex, $3.50; 752, large compound microscope, $19; 733, magic lantern, $15; 740, set of astronomical sliders for the magic lantern, $20; six comic sliders for magic lantern, $7.50; sliders representing blooming carnation, $1.25; death on the pale horse, $1.25. $94.75.

Electricity.—Fig. 270, twenty inch plate electrical machine with mahogany frame, $38; 276, Leyden jar, $1.25; 277, discharger, $1.25; 291, battery of four quart jars, $6.50; 281, quadrant electrometer, $1.25; 275, insulating stool, $3; 296, bells, $2; 300, plates and dancing images, $1.25; 294, magic picture, $1.75; 305, long hair man, 75c.; 302, one dozen pith balls, 25c.; 316, orrery, $2.50; 314, horsemen, $2.50; 332, aurora tube, used also as guinea and feather tube in pneumatics, $6; 335, spiral tube, $2.50; 337, luminous word, $3; 322, bucket and syphon, $1; 345, pistol, $3; 341, fire house, $4.

$81.75.

Pneumatics.—Fig. 177, best lever air pump with mahogany frame, $70; 188, bell receiver, $2; 217, open top receiver, $2.50; 217, plate with slide rod, $2.50; 191, hand and bladder glass, 75c.; 211, air shower, 75c.; 212, mercury cup, $1; 195, pressure glass, 75c.; 196, bolt head experiment and jar, $1.25; 197, Magdeburgh hemispheres, $5; 200, fountain, $5; 208, weight lifter, $6; flexible tube, $2; 214, globe to weigh air, $1.75; 219, bell, $2.50; 222, Torricellian experiment, $3.50; 225, freezing apparatus, $1.75; 228, flint and steel in vacuo, $5; 235, water hammer, 75c.; 185 or 186, condensing apparatus with jets, revolving jet, air gun barrel, &c., $13.50. $128.25.

Hydraulics and Hydrostatics.—248, syphon, 75c.; 249, Wirtemberg syphon, 75c.; 102, spirit level, $1; 238, hydrometer, 75c.; 250, Tantalus cup, $2; 252 and 253, lifting and forcing pump in frame, $10; 255, instrument to show the rise of water to its level, intermitting springs, &c., $7.50; 259, hydrostatic bellows, $5; 260, vessel for spouting fluids, $5. $32.75.

Galvanism, Magnetism, &c.—400, Grove's battery, twelve series, large size, with glass vessel for collecting gas; 402, charcoal points, &c., $18; 391, cylindrical pot battery, $2.50: 424, electro-magnet, $1.50; 426, magic circle, $1.75; 427, iron rod supported in air, $2; 407, powder cup, 75c.; 431, Œrsted's experiment, $3.50: 432, galvanometer, $3.50; 428, magnetizing helix, $2.50; 449, wheel engine, $6.50; 452, beam engine, $12; 410, horse-shoe magnet, $1; 86, mariner's compass complete, $2.50; 418, star plate, 50c.; 418, revolving armature, $1; 418, Y armature, 50c.; 418, cross bar armature, 75c.; soft iron rods, links, filings, 25c. $60.50.

Chemistry.—Figs. 484 and 485, six glass retorts, assorted sizes, three of them stoppered, $2.25; 489, two receivers, 75c.; 483, two bolt heads, 68c.; 482, six flasks, 50c.; 481, three bell glasses, one quart, one half gallon, and one gallon, $2.25; one stoppered do., half gallon, $1; two wide mouth glass jars with stoppers, for receiving gases, $1; 487, iron retort, $2; eight feet of small lead pipe, 50c.; 514, retort stand, $1.50; 511, spirit lamp, 75c.; 499, glass tubes, 25c.; 493, three precipitating glasses, 50c.; 494, funnel, 15c.; 495, graduated measure, 63c.; 502, six test tubes, 31c.; 504, air thermometer, 19c.; Torricellian tube, $1; 509, nest of crucibles, 10c.; two evaporating dishes, 72c.; 512, mortar, $1; 536, compound blow pipe with pneumatic cistern, $8; 525, bell glass with cap, two stop-cocks, union, jet, pipe, and gas bag, $4; 408, blow pipe, 38c.; 539, hydrogen generator, $5; 540, hydrogen gas pistol, 38c.; 541, air balloon, $1.25; 542, eolopile, 88c.; 547, pulse glass, 50c.; 548, boiling glass, 50c.; 546, flameless lamp, $1.50; 552, conductometer, $1.75; 555, pyrometer, $3,50; 556, condenser, $1; 559, Marcett's steam boiler, $15; 560, Wollaston's steam apparatus, $1.50; 549, chryopherus, $1.75; 572, Woulfe's bottle, $1; bent glass tube, 25c. $79.81.

Meteorological.—Fig. 604, barometer, $10; 587, thermometer with Fahrenheit and centigrade scales, $1.50; 591, day and night register thermometer, $4; 619, Mason's hygrometer, $5; 622, conical rain gauge, $2.50. $23.00.

Set of minerals, 144 specimens, arranged in three trays and mahogany box with lock, $12; set of geometrical solids, $1.25. $13.25.

Or, with the addition of the following, $1000.

Fig. 130, astronomical telescope, $65; 757, solar microscope, $50; 99, theodolite, $100; 176, Atwood's apparatus for laws of falling bodies, $100; 168 to 174, whirling table and apparatus, $75; 455, bell engine, 12.00.

INDEX TO VOLUME II.

ıatic microscope, 237
ıatic telescope, 177
molecules, 250
r, 66
loons, 89
rmometer, 68
ic, 63
e's rotating battery, 26
tus for detecting poisons,

tus for detonating gases,

tus for specific heat, 92
insects, 246
ıres for magnets, 9
al magnet, 5
Needle, 7
mical sliders, 218

's spur wheel, 21
gnets, 5
ter, 116
ter scale, 117
glasses, 64
ngine, 31
gine, 34
ass apparatus, 76
ass receiver, 60
g screw, 76
eflecting polariscope, 198
ipes, 70
ipe and pneumatic cistern,

ad, 61
glass, 91
al lenses, 169
al sliders, 221
lass thermometer, 112
agneto-electric machine,

thermometer, 69
pump, 270

Bulb tubes, 108

Calorimeter, 97
Camera lucida, 189
Camera obscura, 186
Chemical analysis, 106
Chemical apparatus, 60
Chemical furnace, 73
Chemical tongs, 75
Chryophorus, 91
Circular front barometer, 120
Circular magnetic coil, 15
Claude's black glass mirror, 193
Claude's Lorraine glass, 193
Cloth prover, 173
Color blender, 183
Comic sliders, 221
Common thermometer, 111
Comparative scales, 111
Compound blow-pipe, 82
Compound horse-shoe magnet, 6
Compound prism, 183
Condensation of gases, 103
Condensation of liquids by mixture, 101
Conductometer, 93
Conductors for magnetic machine, 54
Conical rain gauge, 142
Connectors, 76
Cooper's lamp furnace, 72
Cooper's mercurial tube, 75
Cosmorama, 185
Crucibles, 70
Culpepper's microscope, 234
Cumming's statical thermometer, 147
Cupping pump, 270
Cylindrical rain gauge, 143

Daguerreotype camera, 188
Daniell's hygrometer, 131

Davy's safety lamp, 90
Day and night thermometer, 113
Deflagrating jar and spoon, 89
Deflagrating ladle, 90
De la Rive's ring, 11
Differential thermometer, 128
Dipping needle. 7
Dissected cone, 269
Dissolving views, 214
Distillation and condensation, 102
Double convex lens, 179
Double eye-glasses, 160
Double lens eye-glass, 171
Double refraction by mechanical force, 199
Double refraction by unequal heating, 200
Downward conducting power of fluids. 95
Draughtsman's camera, 187
Drying tubes, 109
Dr. Black's furnace, 74
Dropping tube, 67
Dr Bird's inversor, 39

Ear trumpet, 269
Electro magnet, 13
Electro-magnetic globe, 20
Electro-magnetic instrum., 11
Electro-magnet. with 3 poles, 24
Engraver's eye-glass, 170
Equivocal or spontaneous generation. 253
Ether jet, 89
Endiometer, 100
Evaporating dishes, 69
Expansion of metal by heat, 93
Eye-glasses, 157
Eye-protectors, 156—165

Fine steel spectacles, 154
Fire syringe, 95
Flexible gas bag, 78
Flexible tubes, 66
Floating coil, 12
Flower microscope, 222
Flameless lamp, 90
Flasks, 60
Focus of a lens, 179
Folding eye-glasses, 162
French movable sliders, 218
Funnels, 64

Galvanometer, 17
Galvanometer, with astatic needle, 18
Gas bubbles, 77
Gas holder, 78
Gasometer, 81
Geometrical solids, 267
Glass-blower's table, 106
Glass box for refraction, 184
Glass retort, 61
Globe receiver, 63
Glass syringe, 101
Glass tubes, 66
Goggles, 165—167
Galilean telescope, 176
Gold leaf galvanoscope, 19
Gould's pocket microscope, [illegible]
Graduated bell glass, 65
Graduated glass jar, 65
Graduated magnetic machine, [illegible]
Graduated measure glasses, [illegible]
Graphic mirror, 190
Gurney's blowpipe, 86

Hand magnifier, 171
Hand spectacles, 161
Hearing trumpet, 269
Helix on stand, 15
Horizontal bell engine, 35
Horse-shoe magnet, 5
Hope's endiometer, 100
Howard's differential thermometer, 128
Hydrogen gas, 79
Hydrogen gas generator, 88
Hydrogen gas pistol, 88
Hydrogen lamp, 87
Hygrometers by condensation, 13[illegible]

Image on the retina, 181
Improved compound microscope, 231
Insect microscope, 223
Inclosed magnetic instrument for shocks, 55
Infusoria, 251
Iron retort, 62
Iron rod supported in the air, 14

Jones' hygrometer, 141

Knight's assay lamp, 72
Knight's furnace, 73

ands, 72
g gas, 80
es, 66
179
hygrometer, 141
iders, 217
ind gauge, 144
over, 173
icroscopic objects, 263
coil machine, 37
microscope, 211

rcle, 14
discs, 9
nterns, 149
c beam engine, 31
c engine, 33
c instruments, 5
c needles, 6
c swan, 10
c toys. 10
-electric machines, 44—

revolving round a wire,

rs, 168
hermometers, 114
arsenic apparatus, 105
vibrating wire, 20
arometer, 123
hygrometer, 135
61
magnetic instrument, 51
s lens, 179
logical instruments, 110
pes, 222
pic sliders, 246
telescopes, 177
f the eye, 180
nd pestle, 71
n barometer, 121
sliders, 217
wires for attraction. 35
ing glass, 193
of the eye, 182

history sliders, 219
f vision, 181
prism. 195
xyde gas, 80
pparatus, 104
frame, 267

***d hygrometer*, 129**

Objects for the microscope, 246
Oersted's experiment. 16
Opaque solar microscope, 242
Opera glass, 174
Optical diagonal machine, 185
Optical instruments, 149
Oxygen gas, 81
Oxy-hydrogen microscope, 245
Oxy-hydrogen polariscope, 202

Page's revolving armature, 28
Page's revolving magnet, 30
Pebbles for spectacles, 151
Pepys' gas transferrer, 101
Periscopic glasses, 151
Phantasmagoria lantern, 204
Pictet's apparatus, 98
Pike's mountain barometer, 122
Pike's rotary magnetic machine, 44
Pike's thermometer, 111
Pipette. 67
Plain barometer, 119
Plano-convex lens, 179
Pneumatic trough, 75
Pocket thermometers, 112
Polariscope, with selenite designs, 199
Polarization of light, 194
Polarization by bending a glass plate, 200
Polemoscope, 192
Porcelain retort, 61
Porcelain tubes, 66
Portable linen prover, 174
Portable magnetic machine, 49
Potash apparatus, 109
Precipitating glasses, 64
Preparation of gases, 79
Prism, 182
Prism for double refraction, 194
Prognosticator, 127
Pulse glass, 91
Pyrometer, 94

Rack astronomical sliders, 218
Radiation of heat, 98
Readers, 159, 163, 154
Recomposition of light, 183
Reflectors for radiating heat, 98
Regulator for modifying galvanic shocks. 39
Retort, 61
Retort receiver, 63

Retort stands, 71
Retort with cup and stop-cock, 106
Revolving cylinders, 27
Revolving electro-magnet, 30
Revolving magnet, 23
Revolving wheel and armatures, 28
Ribbon coils, 41
Ring and ball experiment, 94
Rotary magnetic machine, 44
Rules for observing the barometer, 118

Saussure's hygrometer, 130
Saxton's magneto-electric machine, 55
Scintillating circle, 36
Scripture history sliders, 220
Set of philosophical instruments, for $50, 272
Set of philosophical instruments, for $150, 273
Set of philosophical instruments, for $600, 275
Selenite designs, 197
Self-registering thermometers, 113
Ship telescope, 178
Silver mouth conductor, 54
Single or compound microscopes, 225—227
Sliders of costumes, 220
Solar microscope, 239
Spatulas, 71
Spectacles, 149
Spectacle cases, 157
Spirit lamp, 71
Stanhope lens, 172
Star plate, 9
Steam boiler, 96
Still, worm and tub, 99
Stone-ware furnace, 73
Stone-ware retort, 62
Stop-cocks, 76
Stoppered bell glasses, 60
Storm glass, 127
Sugar boilers' thermometer, 11

Telescopes, 176
Test glasses, 64
Test tubes, 67
Thermo-electric circuit, 40
Thermo-magnetic rectangles, 4
Thermometers, 110
Three-necked bottles, 104
Tourmaline plates, 195
Tourmaline polariscope, 196
Troughton's barometer, 124
Tube and flask holder, 102
Tube of safety, 67
Tubulated receiver, 63
Tubulated retort, 61

Unannealed glass a double fractor, 201
Unequal expansion of fluids,
Universal single pocket mi scope, 223
Ure's eudiometer, 100

Vegetable infusions, 254
Vibrating magic circle, 24
Vibrating magnetic instrum 47
Videscope, 164

Watchmaker's eye-glass, 170
Wheel barometer, 125
Wire revolving round a mag 22
Wollaston's steam apparatus,

282a

A

PRICE CATALOGUE

OF

MATHEMATICAL, PHILOSOPHICAL,

AND OPTICAL INSTRUMENTS,

MANUFACTURED AND SOLD, WHOLESALE AND RETAIL, BY

BENJ. PIKE, Jr.

294 BROADWAY, NEW YORK.

A FEW DOORS ABOVE THE PARK.

The No. refers to the article enumerated; the Fig. to the engraving in the Illustrated Descriptive Catalogue.

MATHEMATICAL INSTRUMENTS.

No.		
1	Fig. 1, set of mathematical instruments, consisting of one pair of compasses with pen, pencil, and dotting point, pair of dividers, ruling pen, pencil, and box scale, in fish skin case, - - - - - - -	$ 2.00
2	Fig. 1, ditto, with the addition of a box sector, and brass protractor, - - - - -	3.50
3	Fig. 1, ditto, steel points, ivory scale, ebony parallel rule and brass protractor, - -	5.00
4	Set of mathematical instruments, consisting of one pair of six inch compasses with ink and pencil point, and lengthener, one pair of three inch compasses with ink and pencil point, pair of dividers, drawing pen, trans-	

No.		
	parent protractor, brass protractor, and two boxwood scales, in mahogany case, $4.50 ; in rosewood case,	$ 5.00
5	Ditto, with bow pen and ivory scale,	7.00
6	Ditto, with extra needle point leg to compasses, both legs jointed, and ivory scale,	9.00
7	Fig. 2, superfine set,	12.00
8	Set of mathematical instruments, consisting of one pair of compasses with ink and pencil points, lengthener, ruling pen, pair of dividers, pencil case, two boxwood scales and protractor, in rosewood case,	$3.50 and 3.75
9	Set of mathematical instruments, in German silver, consisting of one pair of six inch compasses with ink and pencil point, lengthener, pair of dividers, drawing pen, one pair of three inch compasses, with ink and pencil point, ivory scale and transparent protractor, in rosewood case,	15.00
10	Fig. 2, ditto, with extra leg with needle point, both legs of compasses jointed, ivory protractor, parallel rule,	20.00
	Cases of mathematical instruments, more extensive than the above with compasses double jointed in the legs, hair dividers, steel bow instruments, &c.,	$30 to 80.00
11	Fig. 3, 4, 5, 6 and 7, pair of compasses, double jointed in the legs, ink and pencil point, and lengthener in brass,	$10 to 12.00
12	Figs. 3 to 7, ditto in German silver,	$12 to 16.00
13	Pair of six inch compasses with movable leg, pen point, pencil point, and dotting point,	0.88
14	Ditto, with steel joints,	1.00
15	Ditto, with turned cheeks and lengthener,	3.00
16	Fig. 8, hair dividers, in brass or German silver,	$1.75 to 4.00
17	Dividers, from four to seven inches long, brass joint,	19 cts. to 0.38
18	Dividers, from four to seven inches, steel joint,	31 cts. to $0.63
19	Ruling pens, common, with brass handle,	25 cts. to 0.38
20	Ruling pens, good quality, with ebony handle,	0.75

g. 9, ruling pens, best quality, turn up nibs, ivory handle,	1.25
g. 10, ruling pens, best quality, ivory handle,	1.25
g. 11, road pen, $3.00 and	3.50
g. 5 and Fig. 12, dotting pen, $2.25 to	6.00
g. 13, needle holder,	1.25
w compasses, in brass, $1; in German silver,	1.38
g. 15, bow pen, in brass, $1, in German silver,	1.38
g. 16, bow pencil, brass, $1; German silver,	1.38
g. 17, bow pen, double jointed in legs, brass, $3, German silver,	4.00
g. 18, bow pencil, double jointed in legs, brass, $3, German silver,	4.00
g. 19, bow pen of fine French make, $1.75 to	3.00
g. 20, bow compasses, two inch, with ink and pencil point, brass,	1.75
g. 20, bow compasses, two inch, with ink and pencil point, German silver,	3.00
g. 21, steel bow compasses,	2.00
g. 22, steel bow pen,	2.25
g. 23, steel bow pencil,	2.25
eel universal bow, with pen and pencil to change,	3.50
g. 24, needle point bow instruments, $2 to	7.00
g. 25, proportional compasses in brass, $4 and	4.50
g. 25, “ with adjusting screw, $6 and	6.50
g. 25, “ in German silver,	6.00
g. 25, “ with adjusting screw, in German silver,	8.50
roportional compasses, with adjusting points, $6 to	10.00
g. 25, “ “ extra finish, $10 to	14.00
g. 26, bisecting compasses, in brass, $1.25 German silver,	3.00
g. 27. triangular compasses, in brass or German silver, $4 to	7.50
g. 28, pillar compasses with bow handles, $5 to	7.50
g. 29, universal tube compasses with points to turn, $10 to	15.00
g. 30, beam compass, with brass bar to extend,	7.50

No.
50 Fig. 31, beam compass, - - $6.00 to
51 Fig. 32, pins for fastening paper, brass 75cts. per dozen, German silver, - - - -
52 Fig. 32, centres with pins to fasten to paper, each, - - - - - 25cts. to
53 Fig. 33, protractors in brass, four inch, 50cts.; five inch, - - - - - -
54 Fig. 33, protractors in brass, divided to half degrees, six inch, $1.25; seven inch, -
55 Fig. 33, transparent protractors, in horn, four inch, 25cts.; five inch, - - - - -
56 Fig. 33, transparent protractors, divided to half degrees, six inch, 75cts.; seven inch,
57 Fig. 35, plane scales in boxwood, six inch, 38cts.; twelve inch, - - - - -
58 Fig. 35, plane scales in brass, six inch, $1.75; twelve inch, - - - - - -
59 Fig. 35, plane scales, in German silver, twelve inch, - - - - - - - -
60 Fig. 36, sectors in brass, six inch, $1.50, in ivory, - - - - - - $1.50 and
61 Fig. 37, architect's scales, in brass, six inch, $1.25; nine inch, $1.75; twelve inch,
62 Fig. 37, architect's scales, in German silver, six inch, $1.50; nine inch, $2; twelve inch,
63 Fig. 37, architect's scales, in ivory, six inch, $2.50; nine inch, $3; twelve inch, -
64 Fig. 34, protractors and scales, in ivory, six inch, - - - - - $1.50 and
65 Fig. 34, " " " divided to half degrees, - - - - $2.50 to
66 Fig. 34, " " " stout ivory, nine inch, $7; twelve inch, - - $8 to
67 Fig. 38, parallel rules, in ivory, six inch, $1.50 twelve inch, - - - - - - -
68 Fig. 39, parallel rules with double bar, six inch, $3.50; twelve inch, - - - - $
69 Fig. 38, parallel rules in ebony, six inch, 62cts.; nine inch, 88 cts.; twelve inch, $1; fifteen inch, $1.25; eighteen inch, $1.63; twenty-four inch, $2.50; thirty-six inch, -

Fig. 40, Eckhardt's rolling parallel rule, twelve inch,	5.50
Fig. 41, T squares, of hard wood, twenty-four to thirty-six inches long,	75 cts. to 1.50
Fig. 41, T squares, of hard wood, nine to eighteen inches long,	38 cts. to 1.00
Fig. 42, T squares of hard wood, twenty-four to thirty-six inches with level and screw,	$1.50 to 2.50
Fig. 42, T squares, with steel blade, twenty-four to thirty-six inches,	$3.50 to 5.50
Fig. 43, T squares, with protractor in brass,	$7 to 12.00
Fig. 43, T squares, with protractor, in German silver,	$9 to 18.00
Fig. 44, squares and gauge for measuring diameters, interiors, &c.,	$1.50 to 7.00
Fig. 45, draughtsmen's squares, of hard wood, solid,	25 cts. to 0.50
to 106 Fig. 46, draughtsmen's squares of hard wood, open,	62 cts. to 1.50
Fig. 47 to Fig. 73, curves of various shapes, in hard wood,	25 cts. to 0.50
Fig. 47 to Fig. 73, set of twenty-seven curves of various shapes,	7.00
Fig. 74, centrolinead, right and left, each,	10.00
Fig. 75, best circular protractor, 6 to 12 inch diameter,	$18 to 40.00
Fig. 76, pantagraph in ebony, with brass mounting,	$ 7.50 and 14.00
Fig. 76, pantagraph in brass,	15.00 to 40.00
Gunther's one foot scales,	38.00
Gunther's two foot scales,	0.63
Two foot box scales, divided in twelfths, from one-eighth to one inch,	1.75
One foot box scale,	1.25
Wantage rods,	$38 cts. to $0.63
Gauging rods,	75 cts. to 2.00
Gauging callipers,	$6 to 8.50
Yard sticks, graduated both sides,	25 cts. to 0.50
Whalebone *pocket* measures, very elastic, one *to three feet,*	$1 to 2.00

SURVEYORS' INSTRUMENTS, COMPASSES, &c.

No.		
122	Fig. 77, surveyors' chains, two poles or fifty links,	$1.50 and $1.25
123	Fig. 77, surveyors' chains, four poles or 100 links,	$2.25 and 2.75
124	Fig. 78, perambulator or measuring wheel,	50.00
125	Fig. 79, tape measures, in leather boxes, twenty-five feet, $1.25; thirty feet, $1.37; forty feet, $1.50; fifty feet, $1.75; sixty feet, $2.00; one hundred feet,	3.00
126	Tape measures with multiplying wheel sixty feet,	3.00
127	Fig. 80, tape measures in brass boxes, three feet, 63 cts.; six feet, 88 cts.; twelve feet,	1.25
128	Fig. 80, tape measures with spring, three feet, $1.00; six feet,	1.50
129	Fig. 80, tape measures with spring in German silver and pearl,	2.00
130	Whalebone measures, one to three feet long, folding into three inches,	$1 to 2.00
131	One foot ivory four fold rules,	0.50
132	Fig. 81, plumb bobs with steel points, three and a half inch,	1.50
133	Fig. 82, pocket compasses in brass boxes, three sizes,	38 cts., 50 cts., and 0.63
134	Fig. 83, pocket compasses, gilt, watch form, two sizes,	$1 and 1.25
135	Fig. 83, pocket compasses, brass, watch form, with stop,	1.50
136	Fig. 83, pocket compasses, brass, watch form, stop and agate centre,	2.25
137	Fig. 84, pocket compasses, strong gilt, watch form, full divided enamelled dial, stop, jewelled cap, and edge bar needle,	$ 9.00

Fig. 84, pocket compass, as last, in silver, and morocco case, - - - - -	12.00
Fig. 85, pocket compasses in mahogany cases, with stop, five sizes from two to four inches,	$1.25, $1.50, $2.00, 2.50, and 3.00
Fig. 86, mariners' compasses, with wood bowl and brass gimbals, - - - -	2.50
Fig. 86, mariners' compasses with brass box and gimbals, - - - - - -	5.00
Fig. 87, boat compass in brass, -	$2.25 to 2.75
Fig. 88, azimuth compass, - -	8 to 25.00
Fig. 89, prismatic compass, - -	16 and 20.00
Fig. 90, plane table, - - -	20 to 35.00
Fig. 91, surveyors' cross, - - -	3 to 6.00
Fig. 92, surveyors' compass, four inch needle,	14.00
Fig. 92, " " five "	$20 to 22.50
Fig. 92, " " six "	28 to 32.00
Fig. 92, " " with Nonius, five inch needle, - - - - - -	30.00
Fig. 92, surveyors' compass, with Nonius, six inch needle, - - - - -	$35 to 42.00
Fig. 93, portable surveyor's compass, - -	5.00
Fig. 94, graphometer, 8 inch, $15; 12 inch,	30.00
Fig. 95, quadrants, with ebony frames, in cases, - - - -	$ 14 to 18.00
Fig. 96, sextants, best double frame,	100 to 120.00
Sextants, single frame, - - -	50 to 80.00
Sextants, ebony frame, - - - -	35.00
Fig. 97, portable box sextant, - -	30 to 40.00
Fig. 98, reflecting circle, - -	150 to 200.00
Fig. 99, theodolite, with horizontal and vertical movements, and tangent screw, five and six inch, - - - -	$100 to 120.00
Pike's theodolite, improved, with 9 inch plate, 6 inch compass, 15 inch telescope, forming a universal instrument, - - - -	130.00
Fig. 99, theodolite, with silver arch, 5 inch,	
Fig. 100, spirit level tubes, -	25 cts. to 0.50
Fig. 101, spirit levels, mounted in brass, 3 to 12 inches, - - - -	$1.25 to $6.00
Fig. 102, spirit levels, mounted in mahogany, *with brass plate,* - - - - -	1.00

No.		
166	Fig. 103, spirit levels, 27 inch, in mahogany, with plumb level, - - - -	2.00
167	Fig. 103, spirit levels, with plumb levels, brass bound, - - - - -	3.00
168	Spirit levels, in brass, with sights, 6 inch, -	6.00
	" " " 8 inch, -	8.00
169	Fig. 104, spirit levels, with telescope, -	12.00
170	Fig. 105, engineer's Y spirit level, 20 inch,	80 to 100.00
171	Fig. 105, " " with compass,	100.00
172	Fig. 106, Troughton's level, - - -	100.00
173	Fig. 100, spirit level tubes, ground inside, for surveying instruments, - -	$1.50 to 3.00
174	Fig. 107, levelling staves, 10 to 12 ft. long,	$5 to 8.00
175	Fig. 107, portable levelling staves, -	5 to 8.00
176	Fig. 108, level for slopes, or anglemeter,	6 to 8.00
177	Miner's level, compass, and anglemeter, -	6.00
178	Fig. 109, dipping needle, - - -	40 to 50.00
179	Fig, 110, goneometer, for measuring the angles of crystals, - - - -	$3 to 5.00
180	Fig. 111, Wollaston's reflecting goniometer,	20.00
181	Fig. 112, artificial horizon, roof kind,	$20 to 25.00
182	Fig. 114, artificial horizon, circular plate and level, - - - - - -	$6 to 12.00

ASTRONOMICAL INSTRUMENTS.

183	Fig. 115, eighteen inch globes on best high mahogany frames, the pair, - - - -	$78.00
184	Fig. 115, eighteen inch globes on best high mahogany frames, with compasses, -	85.00
185	Fig. 115, thirteen inch globes on high mahogany frames, the pair, - - - - -	35.00
186	Fig. 115, thirteen inch globes on high mahogany frames, with compasses, - -	40.00
187	Fig. 116, thirteen inch globes on low frames, the pair, - - - - - -	25.00

8	Fig. 116, twelve inch globes on low frames, the pair, - - - - - - -	$25.00
9	Fig. 116, twelve or thirteen inch terrestrial globe only, the pair, - - - - -	13.00
0	Fig. 116, ten inch globes on low frames, the pair, - - - - - - - -	20.00
1	Fig. 117, nine inch globes, best London make, the pair, - - - - - - - -	15.00
2	Fig. 117, six inch globes, " " " the pair, - - - - - - - -	7.50
3	Fig. 117, three inch globes, " " " the pair, - - - - - - - -	3.50
4	Fig. 117, five inch terrestrial globe, - -	1.25
5	Fig. 117, three inch terrestrial globe, - -	0.75
6	Fig. 117, five inch terrestrial and celestial globe, the pair, - - - - - -	2.50
7	Fig. 118, five inch terrestrial globe, - -	1.50
8	Fig. 118, three inch terrestrial globe, - -	1.00
9	Fig. 119, globe quadrant for eighteen inch globe, $2; for twelve or thirteen inch, -	1.25
0	Fig. 120, armillary sphere, thirteen inch, on high frame, with compass, - - - -	40.00
1	Fig. 120, armillary sphere, thirteen inch, -	20.00
2	Fig. 121, armillary sphere, plain make, nine inch, $4; twelve inch, - - - - -	5.00
3	Vale's globe and transparent sphere, twelve inch, - - - - - - - - -	25.00
4	Fig. 122, planetarium on high mahogany frame, with wheel work, - - - -	50.00
5	Fig. 123, planetarium on brass stand, with wheel work, - - - - - -	15.00
6	Fig. 123, planetarium on mahogany stand, with wheel work, - - - - -	7.50
7	Fig. 124, planetarium on mahogany stand, movable by hand, - - - - -	5.00
8	Fig. 125, tellurium on brass stand, - -	13.50
9	Fig. 125, tellurium on mahogany stand -	7.00
0	Fig. 126, eclipse instrument, - - - -	5.00
1	Fig. 127, tide dial, - - - - - - -	4.00
2	Fig. 128, centrifugal hoops for showing the earth an oblate spheroid, - - - -	2.50
3	Fig. 130, *astronomical* telescopes with brass	

No.		
	tubes and stand, rack motion to eye-piece, one terrestrial and two celestial eye-pieces, with main tube twenty inches long, - -	$ 42.00
214	Fig. 130, astronomical telescope as above, thirty inch, - - - - - - -	60.00
215	Fig. 130, astronomical telescope as above, thirty-six inch, - - - - - -	90.00
216	Fig. 130, astronomical telescope as above, forty-two inch, - - -	$150 to 200.00
217	Fig. 132, improved astronomical telescope, sixty inch, - - - - - - -	150.00
218	Fig. 133, most improved astronomical telescope, with best stand, four eye-pieces, tube over five feet long, diameter of object glass four inches, - - -	$275 to 350.00
219	Reflecting telescopes, from - -	20 to 100.00
220	Fig. 134, astronomical transit instruments,	$150 to 300.00
221	Fig. 135, altitude and azimuth instruments,	500.00
222	Fig. 136, sun dials of brass, silvered, six inch diameter, - - - - - -	4.50
223	Ditto, seven inch, $5.50 ; eight inch, $7.50 ; twelve inch, - - - -	$10 to 15.00
224	Fig. 136, sun dials of marble, with brass style, seven and a half inch diameter, $4 ; eleven inches diameter, $6.50 ; thirteen inches diameter, - - - - - -	8.00
225	Fig. 138, sun dial of marble, eighteen inches diameter, elegant, - - - - - -	18.00
226	Fig. 139, sun dial with lens and cannon, seven and a half inch diameter, $8.50 ; nine and a half inch, - - - - - - -	12.50
227	Fig. 140, universal ring dial, - -	$6 to 25.00
228	Fig. 141, universal joint dial with compass,	5 to 25.00
229	Fig. 142, time glasses, two to five minutes, in bronze frames, - - - - - -	0.50
230	Fig. 143, time glasses, quarter hour, in plain frame, 88 cts. ; polished rosewood, - -	1.88
	Time glasses, half hour, in plain frame, $1 ; polished rosewood, - - - -	2.00
	Time glasses, one hour, in plain frame, $1.25 ; polished rosewood, - - -	2.25

No.		
	Time glasses, two hour, in plain frame, $1.75; polished rosewood, - - -	$ 3.00
231	Time glasses for medical men in examining the pulse, half minute, - - - -	1.00

MOTION, MECHANICS, &c.

232	Fig. 144, inertia apparatus, - - - -	1.50
233	Fig. 145, pair of glass adhesion plates with handles, - - - - - - -	1.50
234	Fig. 146, Bohnenberger's machine, - -	5.00
235	Fig. 147, apparatus for illustrating impenetrability, - - - - - - -	1.00
236	Fig. 148, set of tubes mounted, for showing capillary attraction, - - - - -	1.00
237	Fig. 149, pair of glass plates for capillary attraction, - - - - - - -	1.50
238	Fig. 150, collision balls, set of five in ivory, four sizes, - - $1.25, 2.00, 3.00 and	4.50
239	Fig. collision balls mounted on frame with arch, - - - - - - - $7 to	12.00
240	Fig. 150, set of five boxwood collision balls,	1.00
241	Fig. 150, set of five boxwood collision balls, and frame with arch, - - $3.50 to	7.00
242	Fig. 151, machine for showing the composition of forces, - - - - - -	5.00
243	Fig. 152, rocking horse for illustrating the centre of gravity, - - - - - -	1.00
244	Fig. 152, a pair of mahogany blocks with wires for centre of gravity, - - -	1.00
245	Figs. 153 to 157, set of mechanic powers, with graduated framework, six systems of pulleys, wheel and axle, levers of first, second, and third order—compound levers, bent levers, screw with lever—inclined plane with graduated arch, carriage wedge in two parts, and a set of brass weights,	35.00

No.		
246	Figs. 154, 155, 156, and 158, set of mechanic powers, with graduated framework, four systems of pulleys, wheel and axle, levers of first, second and third order—bent lever, screw with lever, inclined plane with graduated arch, carriage wedge in two parts, and a set of brass weights,	$16.00
247	Fig. 159, 160, 161, 162, and 163, improved and elegant set of mechanic powers, consisting of a complete set, with an apparatus for the composition and resolution of forces. The whole mounted on four polished mahogany frames, uniform in their size and finish,	60.00
248	Fig. 164, screw press,	2.25
249	Fig. 165, endless screw,	$6 and 8.00
250	Fig. 166, capstan,	2.50
251	Fig. 167, double cone,	$1.50 and 2.00
252	Fig. 167, double cone with adjusting screws,	3.00
253	Fig. 168 to Fig. 174, whirling table, for explaining and demonstrating the laws of the planetary motions, and other properties of gravity and centrifugal forces,	75.00
254	Fig. 175, whirling table of simpler construction, with the apparatus represented in Figs. 169, 170, 171, 172, 173, and 174.	30.00
255	Fig. 176, Atwood's elegant and accurate apparatus for demonstrating the laws of accelerated and retarded motion, and other interesting laws in mechanics, with clock beating seconds,	100.00
256	working model of steam engine,	$35.00 to 90.00

PNEUMATICS.

AIR PUMPS AND APPARATUS.

257	Fig. 177, improved lever air pump, with mercury gauge and polished mahogany frame,	70.00

Fig. 177, ditto, with rosewood frame, - -	$ 75.00
Fig. 209, small size lever air pump, barrel eight inches long and two and a half inches diameter, - - - - - - -	20.00
Fig. 178, French table air pump, frame all brass, large size, - - - -	75.00
Fig. 178, ditto, second size, - - -	50.00
Fig. 179, double barrel table air pump, large size, - - - - - - $40 and	45.00
Fig. 180, double barrel table air pump, small size, - - - - - - $22.50 and	25.00
Fig. 181, Pike's improved double barrel air pump, $65 ; in rosewood frame, - -	70.00
Fig. 182, single barrel air pump, small size,	7.00
Fig. 182, " " " " medium size,	9.00
Fig. 183, " " " " large size,	12.00
Fig. 184, Pike's improved single barrel air pump with raised plate, - - -	18.00
Air pumps, small size, without plate and stand, &c., - - - - - - $3 to	5.50
Fig. 185, improved condensing apparatus with glass chamber, - - - - - -	10.00
Fig. 186, improved condensing apparatus with copper chamber, - - - -	10.00
Either of the two last with revolving jet, -	12.00
" " " " " " and air gun barrel, - - - - - -	13.50
Fig. 187, lever condenser on frame, - -	20.00
Fig. 188, swelled air pump receivers, four inch, 75cts. ; five inch, $1 ; six inch, $1.25 ; seven inch, $1.50 ; eight inch, $1.75 ; nine inch, $2 ; ten inch, $2.50 ; twelve inch,	4.00
Fig. 189, low receivers for the air pump, five inch, 75 cts. ; six inch, $1 ; seven inch, $1.37 ; eight inch, - - - - -	1.75
stop-cocks for air pump, three inch, - -	1.00
Connecting screws, guard screws, &c., each,	0.50
Fig. 190, gallows connector, - - -	1.50
Figs. 191 and 192, hand and bladder glass,	0.75
Fig. 193, bladder glass with cap and stop-cock, - - - - - - - -	2.0
Fig. 194, apple cutter, - - - - -	1.5

No.		
283	Fig. 195, pressure glass,	$ 0.75
284	Fig. 196, bolt head experiment, $1; jar for ditto, 25 cts.,	1.25
285	Fig. 197, Magdeburgh hemispheres, three and a half inch diameter, brass, $4; four and a half inch ditto,	6.00
286	Fig. 197, Magdeburgh hemispheres, three and a half inch diameter, in iron, $4; four and a half inch in ditto,	5.00
287	Fig. 198, lever and stand for weighing a column of air,	5.00
288	Fig. 199, spouting tube,	2.50
289	Fig. 200, fountain in vacuo, two sizes, $4.50 and	5.00
290	Fig. 201, expansion fountain,	3.50
291	Fig. 202, three globe fountain by elasticity,	2.50
292	Fig. 203, lungs glass,	2.00
293	Fig. 204, guinea and feather receiver and drops,	10.00
294	Fig. 205, guinea and feather tube, - $4 and	6.00
295	Fig. 206, bladder and weights, - $1.75 and	2.00
296	Fig. 207, weight lifter by expansion of air,	5.00
297	Fig. 208, weight lifter with glass cylinder, 3 inch cylinder,	6.00
298	Fig. 208, weight lifter with glass cylinder, 3½ inch cylinder,	8.00
299	Fig. 209, large weight lifter, with scale board, 4 inch cylinder,	15.00
300	Fig. 210, weight lifter with brass barrel,	7.50
301	Fig. 210, air shower (used on hand glass),	0.75
302	Fig. 212, mercury cup " "	1.00
303	Fig. 213, tube for mercury shower, $4 and	5.00
304	Fig. 214, flask with stop-cock for weighing air,	2.00
305	Fig. 214, " with steel beam and brass stand,	6.00
306	Fig. 215, balance beam and cork ball	3.50
307	Fig. 216, receiver with sliding rod, $3.50 and	4.00
308	Fig. 219, " " " bell-shaped, $4 and	5.00
309	Fig. 217, open-top receiver, with plate and sliding rod	5.00
310	Fig. 218, bell in vacuo, 3 sizes, $2.25, $2.50, and	3.00
311	Fig. 219, improved spring bell in vacuo, $2.50 and	3.00
312	Fig. 220, float wheel for showing the resistance of the air,	0.75

No.		
313	Fig. 222, Torricellian experiment with tall receiver,	$ 5.00
314	Fig. 222, Torricellian experiment, with tube to slide, $3.50 and	4.00
315	Fig. 223, Torricellian experiment used with flexible tube,	5.00
316	Fig. 224, water pump in vacuo, with receiver,	8.00
	" " without "	5.00
317	Fig. 225, freezing apparatus, $1.50 and	2.00
318	Fig. 226, freezing apparatus, with thermometer, $5 and	7.00
319	Fig. 127, Wollaston's chryophorus in vacuo, with receiver,	5.00
320	Fig. 228, flint and steel in vacuo; common,	3.50
	" " " best,	5.00
321	Fig. 229, apparatus to fire gunpowder in vacuo,	4.50
322	Fig. 230, apparatus for showing the effects of burnt air,	6.00
323	Fig. 230, ditto, tube only, fitting-plate and receiver, Fig. —	1.50
324	Cigar tube for smoke in vacuo	0.50
325	Fig. 231, bursting squares, or thin square glass bottles, for breaking by the inward or outward pressure of the air, each,	0.16
326	Fig. 231, cap and valve for bursting squares,	0.31
327	Fig. 231, wire guard for ditto,	0.75
328	Fig. 232, transferer with two pint receivers, $8; quart, $10; half gallon, $12; gallon,	15.00
329	Single transferer, $3.50 to	6.00
330	Fig. 233, fountain by elasticity,	2.00
331	Fig. 234, water hammer with stop-cock,	2.50
332	Fig. 235, water hammer twelve inches long, 75 cts.; twenty-four inches,	1.50
333	Fig. 236, pressure gauge or indicator,	12.50
334	Fig. 236, vacuum gauge,	12.50

HYDROSTATICS AND HYDRAULICS.

No.		
335	Fig. 237, scales and weights in boxes,	$ 1.25
336	Fig. 237, " " " " fine quality,	3.00
337	Ditto, mounted on a mahogany box with lever stand,	10.00
338	Sets of grain weights, from $\frac{1}{16}$ of a grain to 1000 grains,	4.00
339	Set of troy weights, from	$1.50 to 3.00
340	Set of avoirdupois weights, from	3.00
341	Fig. 238, hydrometer for spirits, in glass,	0.75
342	Fig. 238, " " syrups, alkalies, salts, &c.	0.75
343	Fig. 238, hydrometer for heavy acids,	1.00
344	Fig. 238, alcoholmeter of Guy Lussac,	1.00
345	Fig, 239, brass hydrometer for spirits, syrups, salts, &c.,	4.00
346	Fig. 239, silver hydrometer for spirits, syrups, salts, &c.	6.00
347	Fig. 239, silver alcoholmeter of Guy Lussac,	9.00
348	Fig. 239, brass " " "	6.00
349	Fig. 240, Dica's hydrometer, with thirty-six weights,	25.00
350	Fig. 240, Dica's saccharometer with twelve weights,	25.00
351	Fig. 238, Southworth's silver hydrometer,	10.00
352	Fig. 241, Nicholson's hydrostatic balance	3.50
353	Fig. 242, " " " in brass, highly finished, with morocco case,	6.00
354	Fig. 243, Frye's lactometer for testing the purity of milk,	1.00
355	Lactometer for ascertaining the quantity of cream in milk,	1.50
356	Oleometer for proving the quality of sperm oil,	2.00
357	Fig. 244, urinometer,	1.50
358	Glass jar for urinometer,	0.50
359	Fig. 245, urinometer in case, with apparatus,	7.50

No.		
360	Fig. 238, Twaddell's hydrometers, from No. 1 to No. 6, each,	$ 1.75
361	Twaddell's hydrometers, the set of six complete in a box,	10.00
362	Fig. 238, hydrometers for vinegar, $1 to	2.00
363	Fig. 238, hydrometers for salt manufacturers, showing the per centage of salt contained in any brine,	2.00
364	Fig. 238, hydrometers for ascertaining the quantity of salt in steam boilers, at the temperature of 200 degrees,	1.75
365	Fig. 238, brewers' saccharometers,	2.00
366	Glass hydrometer jar, on foot, three sizes, 50 cts.: 75 cts.; and	1.00
367	Fig. 246, tube for showing the relative weight of fluids, 75 cts to	1.50
368	Fig. 247, hydrostatic figure in glass jar, $2.50 to	4.00
369	Fig. 247, " " only, $1 to	2.00
370	Fig. 248, syphon with drawing tube in glass,	0.75
371	Fig. 248, syphon with drawing tube in metal, 75 cts. and	1.00
372	Fig. 248. syphon, plain, in glass, or brass,	0.38
373	Fig. 249, Wirtemberg syphon in glass, 38 cts. to	0.75
374	Fig. 250, Tantalus cup,	2.50
375	Fig. 251, double bodied vessel,	1.50
376	Fig. 252, lifting pump with glass cylinder, $3 and	4.50
377	Fig. 253, forcing pump with brass or glass cylinder, $5 and	6.00
378	Fig. 254, forcing and lifting pump in mahogany frame, $10 and	12.00
379	Fig. 255, hydrostatic instrument, rise of water to its level,	7.50
380	Fig. 256, hydrostatic equilibrium, $2.50 and	4.00
381	Fig. 257, " paradox,	3.00
382	Fig. 258, " "	5.00
383	Fig. 259, " bellows, $5; extra large,	7.00
384	Fig. 260, vessel for spouting fluids,	5.00
385	Fig. 261, Archimedes' screw,	9.00
386	Fig. 262, Barker's mill,	5.00
387	Fig. 263, centrifugal pump,	10.00
388	Fig. 264, Brahma's hydrostatic press,	40.00
389	*Fig. 265,* hydrostatic paradox with movable *piston,*	25.00

ELECTRICAL MACHINES AND APPARATUS.

No.		
390	Fig. 266, Pike's improved plate electrical machines with highly finished brass conductor, insulated on four glass pillars having four rubbers, and two sets of points for collecting the fluid, mounted on elegant mahogany or rosewood frames,	
	Price, with mahogany frame, 24 in. plate,	$ 75.00
	" " " " 27 in. "	85.00
	" " " " 30 in. "	110.00
	" " " " 36 in. "	130.00
	" " " " 40 in. "	165.00
	" " " " 44 in. "	200.00
	" " rosewood frame, 24 in. "	85.00
	" " " " 27 in. "	95.00
	" " " " 30 in. "	120.00
	" " " " 36 in. "	140.00
	" " " " 40 in. "	180.00
	" " " " 44 in. "	220.00
391	Fig. 267, Pike's improved plate electrical machine, with vertical conductor supported on two glass pillars, with polished mahogany frame. Plate, 13 inches diameter,	25.00
	" 16 " "	30.00
	" 20 " "	38.00
392	Fig. 268, Cuthbertson's plate electrical machine, nine inch plate, $7 ; twelve inch plate, $25 ; sixteen inch, $30 ; twenty inch	38.00
393	Fig. 269, plate glass electrical machine (French plan), twenty inch plate, - -	50.00
394	Fig. 270, plate glass electrical machine, with positive and negative conductor, brass mounted and highly finished.	
	Plate, 16 inches diameter, $20 and	25.00
	" 20 " " $34 and	38.00
	" 24 " "	50.00
	" 30 " "	100.00
	" 36 " "	140.00
	" 42 " "	200.00

No.		
395	Fig. 271, Nairne's cylinder electrical machine, with positive and negative conductors, japanned in imitation of brass, and mounted on glass pillars. Cylinder, 8 in. diameter,	$ 22.00
	" 9 in. "	25.00
	" 10 in. "	28.00
296	Fig. 272, cylinder electrical machine with highly finished japanned conductor. Cylinder, 5 in. diameter,	10.00
	" 6 in. "	12.00
	" 7 in. "	14.00
	" 8 in. "	16.00
	" 9 in. "	18.00
	" 10 in. "	22.00
397	Fig. 273, small cylinder electrical machines. 4 in. diameter,	8.00
	5 in. "	10.00
	6 in. "	12.00
398	Fig. 274, electrophorus with metal plate, $3.50 to	6.00
399	Fig. 275, electrical insulated stool with mahogany top, - - - - - $3 to	6.00
400	Fig. 275, electrical stool, with brass sockets to unscrew, - - - - - - -	4.50
401	Fig. 276, Leyden jar, superior finish, pint $1, to $1.25; quart, $1.25; half gallon, $1.75; gallon, - - - - - - -	$2.50
402	Fig. 277, discharger, with glass handle, -	1.25
403	Fig. 277, discharger, jointed, with glass handle, - - - - - - $2 to	4.00
404	Fig. 278, pith ball electrometer, - -	0.50
405	Fig. 279, " " - -	0·50
406	Fig. 280, balance electrometer, - - -	1.00
407	Fig. 281, quadrant electrometer, boxwood scale, $1.25; ivory, - - - -	1.50
408	Fig. 282, Bennett's gold leaf electrometer, $2 and	2.50
409	Fig. 283, Saussure's electroscope, - -	2.00
410	Fig. 284, Volta's condenser, - - -	6.00
411	Fig. 285, Bennett's electrical doubler, - -	5.00
412	Fig. 286, universal discharger, - - $6 to	7.50
413	*Fig. 288,* medical jar, - - - -	2.50

No.		
414	Fig. 289, discharging or medical electrometer,	$ 2.00
415	Fig. 290, Cuthbertson's balance electrometer,	10.00
416	Fig. 291, electrical battery, four jars, in case, quart, $6.50; four half gallon, $8; four gallon,	10.00
417	Fig. 291, electrical battery, nine jars, quart, $15; half gallon, $18; gallon,	25.00
418	Fig. 292, electrical battery, fifteen jars, quart $22.50; half gallon, $30; gallon,	40.00
419	Fig. 293, Leyden jar with movable coatings,	2.00
420	Fig. 293, “ “ with two sets of movable coatings,	3.25
421	Glass plate with movable coatings,	1.50
422	Fig. 294, magic picture,	1.75
423	Fig. 295, sulphur cone,	0.75
424	Fig. 296, electrical bells, set of three bells,	2.00
425	Fig. 297, “ “ “ two “	1.25
426	Fig. 298, “ “ “ five “	4.00
427	Fig. 299, “ “ (French arrangement),	4.00
428	Fig. 300, electrical plates for dancing images,	1.25
429	Fig. 301, “ “ with adjusting rod,	3.50
430	Fig. 302, electrical pith balls, per dozen,	0.25
431	Fig. 303, glass cylinder with caps for dancing pith balls,	1.50
432	Fig. 304, diverging threads,	0.25
433	Fig. 305, head of hair,	0.75
434	Fig. 306, image of man or woman with long hair,	75 cts. and 1.00
435	Tissue paper tassel,	0.75
436	Fig. 307, radiating feathers,	1.50
437	Fig. 308, electrical swing	3.00
438	Fig. 309, electrical see-saw,	3.00
439	Fig. 310, electrical pendulum,	2.50
440	Fig. 311, electrical spider and jars,	2.75
441	Fig. 312, electrical jar, with ball from outside coating, and spider,	2.50
442	Fig. 313, electrical flyers,	0.50
443	Fig. 314, revolving horsemen on insulated stand, four horsemen,	2.50
444	*Fig. 314,* revolving horsemen on insulated stand, six horsemen,	3.00

No.		
445	Fig. 315, electrical flyers, set of five on one frame, - - - - - -	$ 4.50
446	Fig. 316, electrical orrery, sun, earth, and moon, revolving, - - - - - -	2.50
447	Fig. 317, electrical inclined plane, - -	3.00
448	Fig. 318, sportsman, and Leyden jar, - -	3.00
449	Fig. 318, sportsman only, - - -	1.75
450	Fig. 319, electrical rope dancer, - -	2.00
451	Fig. 320, electrical swan, - - - - -	0.50
452	Fig. 321, rolling glass balls, - - -	5.00
453	Fig. 322, electrical bucket and syphon, 75cts. and	1.00
454	Fig. 323, phosphorus cup, - - -	3.50
455	Fig. 324, electrical wheel, - - -	5.00
456	Fig. 325, electrical saw mill - - -	6.00
457	Fig. 226, rotating bell glass, - - -	4.00
458	Fig. 327, electrical vane, - - - $1 to	2.00
459	Fig. 328, electrical wind mill, - - -	5.00
460	Fig. 329, electrical cross, - - - -	2.50
461	Fig. 330, spiral and flyer, - - - -	3.00
462	Fig. 331, revolving glass globe, - - -	2.50
463	Fig. 332, aurora tube, twenty inch, $4.50; thirty inch, $6; thirty-six inch, - $7 to	10.00
464	Fig. 333, aurora flask, - - - - -	2.50
465	Fig. 334, luminous discharger, - - -	2.00
466	Fig. 335, spiral tube, 16 inch, $2; 20 inch,	2.50
	" " 30 to 48 inch, $3 to	5.00
467	Fig. 336, set of spiral tubes on stand, with revolving balls, - - - - - -	10.00
468	Fig. 337, luminous word, in frame, - -	3.00
469	Fig. 338, luminous crescent, - - - -	3.00
470	Fig. 339, spotted or diamond jar, pint, -	2.00
	" " " quart, -	3.00
471	Fig. 340, egg stand, - - - $1 and	2.00
472	Fig. 341, electrical fire-house, - - -	4.00
473	Fig. 342, electrical belted bottle, - -	3.00
474	Fig. 343, electrical cannon, - - -	2.00
475	Fig. 344, electrical mortar, - - - -	3.00
476	Fig. 345, electrical pistol, - - $2 and	3.00
777	Fig. 346, apparatus for firing gunpowder by electric spark, - - - - - -	3.50
478	Fig. 347, apparatus for firing spirits of wine, ether, &c. - - - - - - -	3.00

No.		
479	Fig. 348, stand for the fusion of wire, by the electric spark,	$ 3.00
480	Fig. 349, ignition of charcoal points in chlorine,	6.00
481	Fig. 350, sphere and point,	1.50
482	Fig. 357, Biot's movable hemispheres and ball,	4.50
483	Fig. 352, Farraday's bent electrical conductor,	1.75
484	Fig. 352, apparatus to show that extending the surface diminishes the quantity of electricity,	2.00
485	Fig. 354, insulated conductor for induction, japanned tin,	2.00
486	Fig. 354, insulated conductor for induction, in brass,	3.00
487	Fig. 355, set of three insulated conductors for induction,	$3 to 8.00
488	Fig. 356, double jar,	3.00
489	Fig. 357, insulated stand,	2.00
490	Fig. 358, series of insulated Leyden jars, each	2.25
491	Fig. 359, Leyden jar, with discharging electrometer,	2.50
492	Fig 360 eudiometer for exploding gases by electricity	$2.50 to 4.00
493	Fig. 361, apparatus for passing an electric spark through gases,	$3 to 6.00
494	Fig. 362, Kinnersley's electrical air thermometer,	3.00
495	Fig. 363, Cavallo's rain electroscope,	2.00
496	Fig. 364, Cavallo's bottle electroscope,	0.50
497	Fig. 365, Coulomb's torsian balance,	$10 to 12.00
498	Fig. 366, dry pile, or electrical chime,	20.00
499	Fig. 367, thunder house,	1.75
500	Fig. 368, thunder house, with insulated sliding rod,	4.00
501	Fig. 369, electrical pyramid,	$2 and 3.00
502	Fig. 370, platina points for lightning rods,	$3 to 4.00
503	Fig. 371, electrical powder house,	6.00
504	Ether cup,	0.50
505	Hydrogen gas generator for charging cannon, &c.	5.00
506	Fig. 372, medical electrical machine,	$12 to 18.00
507	Fig. 374, insulating stool,	$3 to 4.50

No.		
508	Fig. 374, medical jar,	$ 2.50
509	Fig. 374, medical electrometer,	2.00
510	Fig. 375, pair of directors with glass handles for administering electricity medically,	2.50
511	Wooden point, ditto,	0.25
512	Amalgam for electrical machines, per box,	0.12
513	Brass chain for conducting electricity, per foot,	0. 4
514	Gold cord, " " " "	0. 4
515	Pith images, dressed, for image plates, each,	0.75
516	" plain, " " "	0.13
517	Paper figures for image plates, each,	0.12
518	Pith balls for electrical purposes, per dozen,	0.25
519	Pith of elder, per stick, six inches long,	0. 4
520	Brass balls with stems, 15 cts. to	0.50
521	Brass balls, assorted sizes, 12 cts. to	2.00
522	Electrical cylinders, five inches diameter, $1; six inches, ditto, $1.25; seven inch, ditto, $1.75; eight inch, ditto, $2.50; ten inch, ditto,	4.00
523	Glass pillars, for conductors, each, six inches long, 38 cts.; eight inch, 50 cts.; ten inch, 75 cts.; twelve inch,	0.87
524	Glass stool feet, each, 38 cts. to	0.50
525	Glass rods, per pound, 50 cts. to	0.75
526	Rod of sealing wax, one and a quarter inch in diameter, for rubbing,	1.00
527	Glass handles, each, 38 cts. and	0.50
528	Glass tube for rubbing, 12 cts. to	0.50
529	Best tin foil for electrical purposes, square foot,	0. 6
530	Best tin foil, ditto, per pound,	1.00
531	Cement for electrical purposes, per pound,	0.50
532	Price of copal, for rubbing, 25 cts. to	0.50
533	Price of amber, for rubbing,	0.50

VOLTAIC OR GALVANIC BATTERIES, &c.

534	Fig. 380, simple galvanic series in porcelain cups, each series,	0.25

No.		
535	Fig. 381, Farraday's apparatus for showing an electrical current independent of the contact of dissimilar metals, - - -	$ 2.00
536	Fig. 382, pair of circular zinc and copper plates, with glass handles, - - -	2.00
537	Fig. 383, Cruikshank's trough battery, set of 20 pairs, - - - - . -	12.00
538	Fig. 384, ditto, set of 50 pairs,	30.00
539	Fig. 385, galvanic battery, set of 12 pairs,	10.00
540	Fig. 386, Hare's deflagrator, set of 100 pairs,	100.00
541	Fig. 387, Hare's calorimeter, set of 20 pairs,	$15 to 40.00
542	Figs. 388 and 389, Wollaston's galvanic battery, set of 50 pairs, - - - -	50.00
543	Fig. 390, Van Melsen's galvanic battery, set of 25 pairs, - - - - - -	20.00
544.	Fig. 391, cylindrical pot battery, large size,	2.50
545 & 6	Cylindrical pot battery, second size, -	1.75
	small size, - - - - - -	1.50
547	Fig. 392, Daniel's single-cell sustaining battery, - - - - - - - -	1.75
548	Figs. 393, 394, 395, Peron's cells for sustaining batteries, - each 25cts. 13cts. and	0.10
549	Leather cups for sustaining batteries, &c. -	0.50
550	Fig. 396, Daniel's six-cell sustaining battery,	12.00
551	Fig. 397, Daniel's ten-cell sustaining battery,	25.00
552	Fig. 398, improved four-cell sustaining battery, for plating - - - - - -	7.00
553	Fig. 398, improved three-cell sustaining battery for platina, - - - - - -	5.25
554	Fig. 399, Smee's battery (zinc and platinized silver), - - - - - -	2.25
555	Fig. 399, Smee's battery, extra large, -	5.00
556	Fig. 400, Grove's battery (amalgamated zinc and platina),	
557	Set of four, small size, $4.50; medium size,	5.50
	large size, - - - - - - -	6.50
558	Fig. 401, set of six, small size, $6; medium size, $7.50; large size, - - - -	9.00
559	Fig. 400, set of twelve, small size, $12; medium size, $15; large size, - - -	18.00
560	Fig. 400, set of eighteen, large size, - -	27.00

No.		
561	Fig. 400, set of twelve, extra large, as used by Prof. Morse for telegraph, - - -	$ 20.00
562	Fig. 400, set of eighteen, extra large size, -	30.00
563	Fig. 402, apparatus for the decomposition of water by battery, - - - - -	0.75
564	Fig. 403, ditto for collecting the separate gases, - - - - - $4.00 and	5.00
565	Fig. 404, ditto, larger size, - - -	5.00
566	Fig. 405, ditto, with V tube, - $1.50 to	2.00
567	V tube, with platina wires for decomposition,	0.50
568	Fig. 406, decomposition tube, - $1.25 to	1.75
569	Conducting wires with boxwood charcoal points for ignition, - - - - -	0.12
570	Conducting wires with steel watch spring, or iron turnings for ignition and burning, -	9.12
571	Fig. 407, powder cup, - - - -	0.50
572	Fig. 408, pistol to fire by galvanic battery, -	3.00

MAGNETIC INSTRUMENTS.

573	Fig. 409, artificial bar magnets, each, four inch, 25 cts.; eight inch, 50cts. and 75cts.; ten inch, 75 cts. and $1; twelve inch, $1 and	1.50
574	Fig. 410, artificial horse-shoe magnets, two inch, 31 cts.; three inch, 50 cts.; four and a half inch, 75cts.; six inch, $1; eight inch, $1.50; ten inch, - - - - - -	2.25
575 & 6	Fig. 411, compound horse-shoe magnet, six inch, 3 bars, $5; eight inch, do., $7.50; ten inch, do., $10; twelve inch, do., $12.50; twelve inch with five bars, - - $16 to	20.00
577	Figs. 412 and 413, magnetic needles, from four and a half to five inches, 38 cts to	1.00
578	Magnetic needles with agate or ruby caps, four to twelve inches, - - $2.50 to	5.50
579	Fig. 412, wood stand with steel point, 25 cts.; brass stand do., - - - - -	1,00
580	Fig. 414, astatic needle, - - - $2 to	5.00

No.		
581	Fig. 415, dipping needle, - - - $3 to	$6.00
582	Fig. 416, dipping needle, with graduated arch, $3.50 to	5.00
583	Fig. 417, dipping needle, with graduated ring,	6.00
584	Mariner's compass, needle, and eight inch floating card, with mahogany stand and steel point, - - - - - - -	1.25
585	Fig. 418, star and circular discs of soft iron,	0.50
586	Fig. 418, soft iron rolling armature, $1 to	2.00
587	Fig. 418, flat steel bar magnets for breaking, 12 cts. to	0.25
588	Fig. 418, slender cylindrical rods and half links, per dozen, - - - 25 cts. to	0.50
589	Fig. 418, cross bar armature, - - -	0.75
590	Fig. 418, polished iron balls, - - -	0.25
591	Fig. 418, Robinson's forked or Y shaped soft iron armature, - - - - - -	0.50
592	Fig. 418, set of magnetic apparatus, consisting of the last seven instruments, swan and fishes, magnetic needle and stand, bar magnet, and horse-shoe magnet, in a box,	7.50
593	Fig. 419, magnetic swan, fishes, &c., each, 12c. to	0.75
594	Fig. 420, magnetic Neptune, - 75 cts. to	1.00

ELECTRO-MAGNETISM.

595	Fig. 391, cylindrical pot battery, large size,	2.50
596	Fig. 421, De La Rive's ring in floating battery,	1.00
597	Fig. 422, De La Rive's ring, improved, -	1.25
598	Fig. 423, floating coil, - - - - -	1.00
599	Fig. 424, electro-magnet, three sizes, $1.00; $1.50 and - - - - - - -	2.50
600	Fig. 425, large electro-magnet, - - $20 to	40.00
601	Fig. 426, magic circle, four sizes, with ring handles, $1, $1.50, $1.75, and - -	2.50
602	Magic circle, large, with ball and socket handles, - - - - - - -	7.00
603	Fig. 427, helix and iron rod for suspension in the air, $1.75, $3.00, and - - -	5.00

No.		
604	Fig. 428, helix on stand,	$2.50 and $3.00
605	Fig. 429, circular magnetic coil,	2.00
606	Fig, 430, apparatus for Oersted's experiment	3.00
607	Fig. 431, apparatus for Oersted's experiment with graduated circle,	3.50
608	Fig. 432, galvanometer, or galvanic multiplier,	3.50
609	Fig. 433, galvanometer needle suspended by a silk thread,	8.00
610	Fig. 434, galvanometer, with astatic needle,	7.00
611	Fig. 435, improved galvanometer, with ditto,	15.00
612	Fig. 436, gold-leaf galvanoscope, with magnet,	5.00
613	Fig. 437, Barlow's electro-magnetic globe,	3.00
614	Fig. 438, March's vibrating wire,	2.00
615	Fig. 439, Barlow's spur-wheel,	$2.50 to 3.50
616	Fig. 440, ditto, two wheels,	$4 to 5.50
617	Fig. 441, wire revolving round a magnet,	3.50
618	Fig. 442, revolving magnet,	5.00
619	Fig. 443, vibrating magic circle,	6.00
620	Fig. 444, electro-magnet, with three poles,	3.00
621	Fig. 445, magnet revolving round a wire,	9.00
622	Fig. 446, Ampere's rotating battery,	6.00
623	Fig. 447, revolving cylinders,	8.00
624	Fig. 448, Page's revolving armature,	4.00
625	Fig. 449, revolving wheel and armatures,	$6 and 7.00
626	Fig. 460, Page's revolving magnet,	$6 and 7.00
627	Fig. 451, Page's revolving magnet, with electro-magnet,	7.00
628	Fig. 452, magnetic beam engine,	12.00
629	Fig. 453, beam engine with curved armatures,	18.00
630	Fig. 454, magnetic engine,	15.00
631	Fig. 455, bell engine,	12.00
632	Fig. 456, horizontal bell engine,	20.00
633	Fig. 457, movable wires for showing attraction and repulsion,	5.50
634	Fig. 458, scintillating circle,	8.00
635	Fig. 459, Lockey's coil machine with scintillating circle,	12.00
636	Fig. 460, apparatus for detonating gases by magneto-electric spark,	25.00
637	Fig. 461, Bird's inverser,	5.00
638	Fig. 462, water regulator for modifying galvanic shocks,	4.00

No.		
639	Fig. 463, Seebeck's thermo-electric circuit,	$ 5.00
640	Fig. 464, thermo-magnetic rectangle, $1.75 to	2.50
641	Fig. 465, thermo-electric revolving rectangles,	6.00
642	Fig. 466, flat ribbon coils, 100 feet, $4 to	8.00
643	Fig. 567, flat wire coils, - - - $3 to	6.00

MAGNETO-ELECTRIC MACHINES,

FOR MEDICAL AND OTHER PURPOSES.

644	Fig. 468, Pike's rotary magnetic machine, in case, - - - - - - - -	14.00
645	Fig. 469, Pike's vibrating magnetic machine, large size, - - - - - - -	14.00
646	Fig. 470, Pike's magnetic machine, vibrating from both poles, - - - - - -	15.00
647	Fig. 471, Pike's new portable magnetic machines with square batteries, the instrument packed within the battery in neat mahogany or rosewood cases, four sizes, $8, $10, $12, and extra large, - - - - - - -	15.00
648	Fig. 472 Pike's improved portable magnetic machine in polished mahogany case, large size, - - - - - - - -	10.00
649	Fig. 472, ditto, in polished rosewood case,	10.50
650	Fig. 472, ditto, small size, - - - - -	8.00
651	Fig. 472, ditto, small size, in rosewood case,	8.50
652	Fig. 473, insulated conductors with wires, per pair, - - - - - - - -	0.50
653	Fig. 473, ditto, with binding screws to connect wires, - - - - - - - -	1.00
654	Fig. 474, metallic plate for the foot, &c., -	0.25
655	Fig. 474, ditto, with binding screw to connect wires, - - - - - - - -	0.50
656	Fig. 475, brass hand conductors, per pair, -	0.50
657	Fig. 475, ditto, with binding screws to connect wires, - - - - -	1.00

658	Fig. 476, silver conductor for the eye, ear, mouth, with binding screw to connect wire,	$ 0.50
659	Fig. 477, inclosed magnetic machine for shocks,	6.00
660	Fig. 478, magneto-electric machine by large magnet, - - - - - - -	50.00
661	Fig. 479, ditto, by large five bar magnet, $25 to	40.11
662	Fig. 480, magneto-electric machine, by large magnet motion, by toothed wheels, in mahogany box, - - - - - -	32.00
663	Magneto-electric machine, by Winch, in mahogany box, - - - - - -	25.00

CHEMISTRY.

664	Fig. 581, bell-glass receivers, plain, 1 gallon,	$ 1.00
	" " ½ gallon,	0.75
	" " quart, -	0.50
	" " pint, -	0.40
	" " ½ pint, -	0.30
	" " gill, -	0.25
665	Bell glass receivers, stoppered, 1 gallon, -	1.25
	" " ½ gallon, -	1.00
	" " quart, -	0.75
	" " pint, -	0.50
	" " ½ pint, -	0.40
	" " gill, -	0.30
666	Fig. 482, glass flasks, - - 8 cts. to	0.38
667	Fig. 483, matrass or bolt-head, quart, -	0.50
	" " pint, -	0.38
	" " ½ pint, -	0.31
	" " gill, -	0.25
668	Fig. 484, retorts in glass, plain, of white or green glass, - - gill, -	0.25
	" " ½ pint, -	0.31
	" " pint, -	0.38
	" " quart, -	0.50

No.		
669	Fig. 485, retorts in glass, stoppered, of white or green glass, - - gill, -	$ 0.31
	“ “ ½ pint, -	0.38
	“ “ pint, -	0.44
	“ “ quart, -	0.63
	“ “ ½ gallon,	0.88
	“ “ 1 gallon,	1.38
670	Fig. 486, retorts, porcelain, - - $1 to	2.50
671	Fig. 484, retorts, stone ware, glazed, for a great heat, plain, - gill, -	0.40
	“ “ ½ pint, -	0.50
	“ “ pint, -	0.62
	“ “ quart, -	0.75
	“ “ ½ gallon, -	1.00
672	Fig. 485, ditto, tabulated, gill, - -	0.50
	“ ½ pint, - -	0.63
	“ pint, - -	0.75
	“ quart, - -	0.88
	“ ½ gallon, - -	1.25
673	Fig. 487, retorts, iron, with long tube ground into neck, 7 inch, $2 ; 8 inch, - - -	2.50
674	Ditto, with brass connecting screw and union for lead pipe, extra, - - - -	1.00
675	Ditto, of wrought iron, 12 in., with long tube,	3.50
676	Fig. 488, receivers, plain, gill, - - -	0.25
	“ “ ½ pint, - -	0.31
	“ “ pint, - -	0.38
	“ “ quart, - -	0.50
677	Fig. 489, receivers, tubulated, gill, - -	0.31
	“ “ ½ pint, -	0.38
	“ “ pint, - -	0.44
	“ “ quart, - -	0.63
678	Fig. 490, alembic for sublimation and distillation, in glass, - - - - - -	2.50
679	Fig. 491, alembic for sublimation and distillation, in glazed stone ware, - - -	2.50
680	Fig. 492, beaker glasses of thin glass, 25 cts. to	0.37
681	Fig. 493, precipitating glasses, - 15 cts. to	0.25
682	Fig. 494, funnels of ribbed glass, gill 15 cts. ; half pint, 18 cts. ; pint, 25 cts. ; quart, -	0.38
683	Fig. 494, funnels of porcelain, - 38 cts. to	0.75
684	Fig. 494, graduated measure glasses, two oz.,	

63 cts.; three oz., 75 cts.; four oz., $1; eight oz.,	$ 1.25
Fig. 496, graduated glass jars, on foot, $1.50 to	2.50
Fig. 497, graduated bell glass with cup and stop-cock, $2.75 to	4.00
Fig. 498, adapters, 25 cts. to	0.50
Fig. 499, tubes of flint glass, 15 cts. to 37 cts. each; per lb.,	0.63
Fig. 499, tubes of flint glass, quill size, 15cts. to 25 cts. each; per lb.,	1.00
Fig. 499, tubes of glass for pressure and vacuum gauges, 38 cts. to	1.50
Fig. 499, tubes of porcelain, 50 cts. to	1.00
Fig. 499, tubes of stone ware, 25 cts. to	0.50
Fig. 499, tubes of lead, quarter to half inch diameter, per foot,	0.08
Fig. 500, dropping tube or pipet,	0.38
Fig. 501, safety tube, 50 cts. to	1.00
Tube funnels, 25 cts. to	0.50
Fig. 562, test tubes, 6 cts. each; or, per doz., three inch, 38 cts.; four inch, 50 cts.; five inch, 63 cts.; six inch,	0.75
Fig. 503, mahogany frame for test tubes,	1.00
Fig. 504, air thermometer tube,	0.19
Fig. 504, " " " extra large, 25c. to	0.63
Fig. 505, " " " with bottle,	0.50
Fig. 505, " " " with bottle and scale,	1.00
Fig. 506, Boyle's thermometer, 25 cts. to	0.50
Fig. 572, Woulfe's bottles, with three necks, half pint, 62 cts.; pint, 75 cts.; quart,	1.00
Fig. 572, bent tubes for Woulfe's bottles, each, 25 cts. to	0.38
S tubes, for using a flask as a retort, 25 cts. to	0.63
Stirring rods, each, 6 cts. to	0.10
Fig. 507, evaporating dishes in glass, 18 cts. to	0.50
Fig. 507, evaporating dishes in porcelain, 15c. to	0.75
Watch glasses for small evaporating dishes, per dozen,	0.63
Fig. 508, blowpipes, plain brass, 37 cts. and	0.50
Fig. 508, blowpipes, with ball for collecting the moisture, 63 cts. and	0.75

No.			
712	Fig. 508, blowpipe with ball to unscrew,		$ 1.50
713	Black's blowpipe,		0.50
714	Fig. 509, crucibles of refractory fire clay, per nest,	6 cts. to	0.38
715	Crucibles with covers, each,	25 cts. to	1.00
716	Fig. 510, crucibles of porcelain, with or without covers,	20 cts. to	0.50
717	Fig. 511, spirit lamps, in glass, with cap,		0.75
718	Spirit lamps, in brass,	$1 to	2.00
719	Fig. 512, mortar and pestle, in porcelain,	50c. to	1.50
720	Mortar and pestle, in glass,	50c. to	1.00
721	Fig. 513, spatulas, best steel,		0.38
722	Fig. 514, retort stands with heavy iron foot, rod eighteen or twenty inches long, and two rings with thumb screws,		1.25
723	Fig. 515, ditto, with three rings,		1.50
724	Ditto, with large rectangular base, two rods, and four rings,		2.50
725	Ditto, with two rods and six rings,		300
726	Fig. 515, ditto, with brass foot, rod, and rings,	$2 to	4.50
727	Fig. 516, Cooper's lamp furnace,		2.00
728	Fig. 517, Knight's assay lamp,		5.00
729	Fig. 518, Knight's chemical furnace,	$8 to	12.00
730	Fig. 519, furnace of fire clay, with iron hoops,	$4.50 to	7.00
731	Fig. 520, Black's chemical furnace,		15.00
732	Fig. 521, tongs for chemical purposes,	$1 to	2.00
733	Fig. 522, pneumatic trough or cistern, of japanned tin, with fixed and movable shelf, fourteen inches long, ten inches wide, and ten inches deep,		2.00
734	Fig. 522, ditto, larger, sixteen and a half inches long, twelve wide, and twelve deep,		2.50
735	Mercury troughs, from	$3 to	8.00
736	Fig. 523, Cooper's mercurial tube,	37 cts. to	0.75
737	Fig. 524, brass stop-cocks with double male screws,		0.75
738	Fig. 524, connectors, or union joints,		0.25
739	Connectors, with jet,		0.38
740	Connector, with bladder gas bag,		0.38
741	Connector, with pipe for gas bubbles,		0.38

No.		
742	Brass caps, for transfer jars, with screws to fit stopcock, - - -	38 cts. and $ 0.50
743	Fig. 525, bell glass with cap, two stopcocks, connector, jet, gas bag, pipe for gas bubbles, - - - - quart, -	3.75
	" " ½ gallon, -	4.00
	" " gallon, -	4.25
744	Extra large stopcocks, - -	$1 and 1.50
745	Fig. 527, gas bag of India rubber cloth, with stopcock and mouthpiece, for administering nitrous oxide gas; capacity, 2 to 10 galls,	$3.50 to 5.00
746	Gas bags of India rubber cloth, from 1 quart to 10 gallons, - - - -	50cts. to 4.00
747	Gas bags, of India rubber cloth, for gas microscopes, drummond light, &c.	from $4 to 25.00
748	Fig. 528, gas holders, of japanned tin; capacity, 5 to 12 gallons, - - -	$4 to 10.00
749	Gas holders, of wood, 10 to 40 gallons,	$5 to 8.00
750	Fig. 534, compound blowpipe, with two japanned gas holders; capacity, 12 galls. each,	15.00
751	Compound blowpipe jet, - - - - -	2.50
752	Compound blowpipe jet with two stopcocks,	4.00
753	Fig. 533, gasometer, sliding with weights; capacity, 10 to 20 gallons, - -	$10 to 20.00
754	Fig. 535, pair of gasometers for compound blowpipe, with jet and tubes, in japanned tin, the pair, . - - -	$30 to 40.00
755	Fig. 535, ditto, in copper, - -	$40 to 50.00
756	Fig. 536, compound blowpipe and pneumatic cistern, combined, 21 inches long, 12 inches wide, and 12 inches deep, the oxygen gas holder containing two gallons, and the hydrogen 4 gallons, the whole in japanned tin, with brass stopcocks and jet pipes, -	8.00
757	Fig. 536, ditto, made of copper, - - -	10.00
758	Fig. 536, ditto, in tin, of extra large size, -	12.00
759	Fig. 536, ditto in copper, of extra large size, -	16.00
760	Fig. 536, stand for charcoal in using compound blowpipe, - - - - - -	1.50
761	Palmer's oxy-hydrogen jet, with stand for *burning* the gases, - - - - -	7.50

No.		
762	Fig. 537, Gurney's oxy-hydrogen blowpipe,	$ 18.00
763	Fig. 538, hydrogen lamp, - $2, $3, and	4.00
764	Fig. 539, hydrogen gas generator, half gallon size, - - - - - - $4 and	5.00
765	Fig. 539, hydrogen gas generator, gallon, $5 and	7.00
766	Fig. 540, hydrogen gas pistol, - - -	0.38
767	Fig. 541, air balloons, for inflation with hydrogen gas,	
	12 inches long, 7½ inches diameter,	0.56
	15 " " 11 " "	0.75
	19 " " 13 " "	1.25
	26 " " 17 " "	1.75
	30 " " 21 " "	2.50
	36 " " 25 " "	3.25
768	Air balloons in the form of a boy, man, elephant, ox, fish, &c., - - $4.50 to	9.00
769	Fig. 542, eolopile, or ether jet, in glass, -	0.38
770	" " " in brass, -	1.00
771	Fig. 543, deflagrating jar and spoon, quart, 75 cts.; half gallon, $1; one gallon, -	1.25
772	Fig. 544, deflagrating ladle, or spoon, -	0.25
773	Fig. 545, Davy's safety lamp, - $2.50 to	5.00
774	Wire gauze for experiments on flame, 25 cts. to	0.75
775	Fig. 546, flameless lamp, - - $1.25 to	1.75
776	Fig. 547, pulse glass, - - - - -	0.50
777	Fig. 548, boiling glass, - - - - -	0.50
778	Fig. 549, Wollaston's chryophorus, - -	1.75
779	Fig. 550, apparatus to show specific heat, -	4.00
780	Fig. 551, apparatus to show that different fluids expand unequally, - - -	4.00
781	Fig. 552, conductometer, - - -	1.75
782	Fig. 553, instrument to show the expansion of metal by heat, - - - - - -	1.50
783	Fig. 554, ball and ring for showing the expansion of metal by heat, - - - -	2.25
784	Fig. 555, pyrometer, - - - - -	3.50
785	Fig. 556, fire syringe, in brass, - - -	1.00
786	Fig. 557, fire syringe, large size, with glass barrel for showing the flash of light, -	6.00
787	Fig. 558, apparatus to show the downward conducting power, of fluids, - - -	1.00
788	Ditto, with stand, - - - - -	2.00

No.		
789	Fig. 559, Marcett's steam boiler with barometer and thermometer, for experiments on latent heat, &c.,	$ 15.00
790	Fig. 560, Wollaston's steam apparatus,	1.50
791	Fig. 561, calorimeter,	
792	Fig. 562, pair of tin plate mirrors for radiation of heat, with stands, 12 inch diameter,	5.50
793	Fig. 562, ditto, with iron ball and differential thermometer, with stands,	7.50
794	Fig. 562, ditto, in brass, thirteen inch, $20; eighteen inch,	32.00
795	Square box with four different radiating surfaces,	1.50
796	Fig. 563, still and worm of japanned tin,	6.00
797	Fig. 563, " " of copper,	8.00
798	Fig. 564, Hope's eudiometer,	2.50
799	Volta's eudiometer, with platina poles,	3.00
800	" " and graduated,	4.00
801	Fig. 565, Ure's " " "	4.00
802	Fig. 566, Pepy's gas transferrer	0.75
803	Fig. 567, glass syringe for transferring,	0.75
804	Fig. 568, apparatus to show the condensation of liquids by mixture $1 to	3.00
805	Fig. 569, tube and flask holder,	1.50
806	Fig. 570, apparatus for distillation and condensation of liquids, with 3 retort stands,	6.00
807	Fig. 571, apparatus for the condensation of gases, with a retort stand,	3.50
808	Fig. 572, Wolf's apparatus, in tray, $6, $6.50, and	7.50
809	Fig. 572, Bent tubes for Wolf's apparatus, 25cts. to	0.38
810	Fig. 572, Wolf's three-necked bottles, half-pint, 63 cts; pint, 75cts; quart,	1.00
811	Fig. 573, Nooth's apparatus,	15.00
812	Fig. 574, Christison's apparatus for detecting poisons, $.400 and	5.00
813	Fig. 575, Marsh's arsenic apparatus,	2.50
814	Fig. 576, retort, with cap and stopcock,	1.50
815	Specific gravity bottle to hold 1000 grains of water,	3.00
816	Fig. 477, glass-blower's table, with double *bellows*,	25.00

No.		
817	**Fig. 578, apparatus for chemical analysis, -**	**$ 2.50**
818	**Fig. 579, “ “ -**	5.00
819	**Fig. 580, “ “ $7.50 to**	10.00
820	**Fig. 581, one-bulb tube, - - - -**	0.38
821	Fig. 582, two-bulb tube, - - - -	0.50
822	**Fig. 583, five-bulb potash apparatus, - -**	1.25
823	**Fig. 584, drying tube, - - - -**	0.37
824	**Fig. 585, drying tube, - - - - -**	**0.75**
825	Bottles with glass stoppers, 2 ounces, 14cts.; gill, 16cts.; half-pint, 18cts.; pints, 20cts.; quarts, - - - - - - -	0.25
826	Bottles with wide mouths and glass stoppers, two ounces, 15cts.; gill, 18cts.; half-pint, 25cts.; pint, 31cts.; quart, 38cts; half-gallon, - - - - - -	**0.56**

METEOROLOGY.

827	Fig. 586, thermometers in japanned tin case, 6 inch,	0.63
	“ “ 7 inch,	0.75
	“ “ 8 inch,	0.87
	“ “ 10 inch,	1.00
	“ “ 12 inch,	1.25
	“ “ 14 inch,	1.50
	With Reaumur or centigrade scale, 25cts. to 50cts. extra.	
828	Fig. 587, thermometers, with mahogany backs (Pike's improved), - 8 inch,	1.00
	“ “ 10 inch,	1.25
	“ “ 12 inch,	1.50
	“ “ 14 inch,	1.75
829	Fig. 587, ditto, fourteen inch, with Fahrenheit and centigrade scale, and movable index, -	2.50
830	Fig. 588, ornamental mahogany frame thermometer, - - - - 12 inch,	1.75
	“ “ 18 inch,	2.50
	“ “ 24 inch,	6.00

No.		
831	Fig. 589, mahogany frame thermometer, with glass in front, with flat glass, 12 inch,	$ 1.75
	" " " 14 inch,	2.00
	" " " 20 inch,	5.00
	with circular glass, 12 inch,	2.25
	" " " 14 inch,	2.50
	" " " 20 inch,	6.00
832	Fig. 590, thermometer in morocco case, 8 in.,	1.50
833	Fig. 590, " " " with Fahrenheit and Reaumur scale,	1.75
834	Fig. 590, thermometer in morocco case, three to six inch, $1.25 to	1.50
835	Fig. 590, thermometer in morocco case, three to six inch, ivory scale, $1.50 to	2.00
836	Fig. 592, self-registering thermometer for day, or extreme heat,	2.50
837	Fig. 592, self-registering thermometer, for night, or extreme cold,	2.00
838	Fig. 591, self-registering thermometer, for day and night, in one frame,	4.00
839	Ditto, with improved cylinder bulbs,	5.00
840	Fig. 592, self-registering thermometer for extreme heat, with index, extra large size,	3.00
841	Fig. 592, ditto, for extreme cold,	3.00
842	Fig. 586, thermometers for sea use, in copper cases, $1.25 to	2.00
843	Fig. 586, thermometers for low temperatures, with alcohol in tube,	2.00
844	Thermometers with delicate tubes and small light scales for chemical experiments, 75c. to	1.00
845	Chemical thermometer to 400 deg., 10 inch,	1.50
	" " 400 " 12 "	1.75
	" " 400 " 14 "	2.00
	" " 600 " 14 "	3.00
846	Chemical jointed thermometer to 400 deg., fourteen inch,	4.00
847	Chemical jointed thermometer to 600 deg., fourteen inch,	4.40
848	Wollaston's barometrical thermometer, with copper boiler,	6.00
849	Medical thermometers, $1 to	5.00
850	*Ivory steeple* " highly ornamented, $8 to	15.00

No.		
851	Fig. 593, thermometers for sugar boiling, mahogany frame, three feet, - - -	$ 4.00
852	Fig. 593, thermometers for sugar boiling, with index, three feet, - - - - -	4.50
853	Fig. 593, thermometers for sugar boiling, mahogany frame, four feet, - - -	5.00
854	Fig. 593, thermometers for sugar boiling, with index, four feet, - - - - -	6.00
855	Fig. 594, thermometers for sugar boiling, brass case, three feet, - - - - -	5.50
856	Fig. 594. thermometers for sugar boiling, brass case, four feet, - - - - -	7.00
857	Figs. 595 to 603, thermometers for mantel, Gothic frames, over twenty-five different patterns, from - - - - - $1 to	2.50
858	Fig. 604, pediment barometer with thermometer, plain mounting, - - - - -	10.00
859	Fig. 605, pediment barometer with thermometer and glass door, - - $11 and	12.00
860	Fig. 606, ditto, with large thermometer, -	16.00
861	Fig. 607, ditto, with best circular front, $20 to	25.00
862	Fig. 608, mountain barometer in small round case, - - - - - - - -	20.00
863	Fig. 608, mountain barometer with corrections,	25.00
864	Fig. 608, Pike's mountain barometer for academies, &c., - - - - $10 and	12.00
865	Fig. 609, Pike's standard barometer, - -	22.00
866	Fig. 610, marine barometer on gimbals, $20 to	25.00
867	Fig. 611, Troughton's mountain barometer, with brass frame and portable folding staves and gimbals, - - - - - -	45.00
868	Fig. 612, wheel barometer, mahogany frame, dial, eight inch, $12 ; ten inch, - -	15.00
869	Fig. 612, wheel barometer, rosewood frame, eight inch, $15 ; ten inch, $18; twelve inch, - - - - - - - -	25.00
870	Fig. 612, wheel barometer, with rosewood case inlaid with pearl, - - - - -	25.00
871	Fig. 613, prognosticator, or storm-glass, -	1.25
872	Fig. 614, differential thermometer, on stand,	1.50
873	Fig. 615, Howard's " "	1.50

No.		
874	Fig. 616, hygrometer for showing the dryness or moisture in the air, &c.	$ 2.50
875	Fig. 617, Saussure's hygrometer,	5.00
876	Fig. 618, Daniell's "	14.00
877	Fig. 619, Mason's " $3.50 to	5.00
878	Fig. 619, ditto, stand, packed in rosewood case,	7.00
879	Fig. 620, Jones's hygrometer,	5.00
880	Fig. 621, Leslie's thermometric hygrometer,	5.00
881	Fig. 622. conical rain gauge,	2.50
882	Fig. 623, cylindrical rain gauge, with graduated tube,	7.50
883	Fig. 623, " " with float,	6.00
884	Fig. 624, Lind's wind gauge, $6 to	8.00
885	Fig. 625, Cumming's statical thermometer,	25.00

SPECTACLES, EYE-GLASSES, &c.

886	Figs. 628 and 632, gold spectacles, with single joints, octagon, oblong, or oval eye, $7 and	8.00
887	Figs. 629 and 632, ditto, extra fine, 9 and	10.00
888	Figs. 630 and 631, gold spectacles, double jointed, with slide or turnpin, $8 and	9.00
889	Figs. 630 and Fig. 631, ditto, extra fine, $10 to	13.00
	Best pebble eyes, extra, for concave,	2.50
	" " for convex,	1.75
890	Figs. 629 and 632, silver spectacles, single jointed, $2.00; extra,	2.25
891	Figs. 630 and 631, silver spectacles, double jointed, with slide or turnpin,	2.00
	" " extra, $2.25 to	2.50
892	Fig. 635, steel spectacles, blued, of fine quality, single joints, very elastic and light, with octagon, oblong, or oval eyes, $2 to	2.50
893	Fig. 635, ditto, of good quality, $1.25 and	1.50
894	" inferior, 62cts. to	1.00
895	Figs. 633 and 634, steel spectacles, blued, of fine quality, very elastic and light, double joints, with oval, oblong, or octagon eyes, $2.50 and	3.00

No.		
896	Fig. 634, steel spectacles, good quality, $1.25 and	1.50
897	Fig. 634, ditto, of inferior quality, 75cts. and	1.00
898	Steel spectacles, stout, highly polished, oval eyes, turnpin on sliding bows, best quality glasses, 75cts.; inferior, - - -	0.38
899 & 900	Fig. 636, tortoise-shell spectacles, very light, single jointed, $2; double, - -	3.00
901	Tortoise-shell spectacles, silver sides, $2.50 to	3.50
902	Gilt, and gilt on silver spectacles, $2 to	3.00
903	German silver spectacles - - 50cts. to	1.00
904	Horn-mounted " - - 75cts. to	1.25
905	Fig. 637, spectacles for reading and public speaking, in fine steel, silver, or gold mounting, - - - - $1.50 to	10.00
906	Spectacles for eyes that have been couched, $1 to	3.00
907	Fig. 638, spectacles with folding side glasses, of blue or neutral tint, for weak or inflamed eyes, in fine elastic steel, $4.50 and	6.00
908	Ditto, of ordinary quality, - - $1.50 to	2.50
909	Ditto, with silver mounting, - $3 to	6.00
	All the above are set with best concave or convex, blue, neutral tint, or green glasses, and a morocco case included.	
	Spectacles, with blue or green convex glasses, extra, - - - - - - -	0.25
	" with blue or green concave glasses, extra,	0.50
	" with truly ground periscopic glasses, extra, - - - - - -	0.50
	" with best Brazil pebbles, convex, extra,	1.75
	" " " " " concave, "	2.50
	" with divided glasses for two sights, extra, - - - - - -	0.50
910	Fig. 639, morocco spectacle cases, fine quality,	0.12
911	Fig. 639, " " " ordinary,	0.10
912	" " " long, for ladies' spectacles, - - - - - -	0.12
913	Spectacle cases in tortoise shell, silver mounted, - - - - - - $2.50 to	4.50
914	Spectacle cases in German silver, 50 cts. to	0.75
915	" " in steel, - - - - -	0.38
916	Fig. 640, eye glasses, in black horn mounting, round, - - - - - - -	0.63

No.		
917	Fig. 641, eye glasses in black horn mounting, square, - - - - - - -	$ 0.63
918	Fig. 642, eye glasses, in tortoise shell mounting, - - - - - - - -	1.00
919	Eye glasses, in silver mounting, - - $1 to	1.25
920	Fig. 642, eye glasses, in fine steel mounting, $1 to	1.25
921	Fig. 643, " " in gold plated " $2 to	3.00
922	Fig. 644, " " " " " $3 to	5.00
923	" " in solid gold "	5.00
924	Fig. 645, reader, in gold, plated " large size, - - - - - - $4 to	5.00
925	Fig. 646, eye glasses for both eyes, in black horn mounting, - - - - - -	1.25
926	Fig. 646, eye glasses for both eyes, in tortoise-shell mounting, - - - - - -	1.75
927	Fig. 647, eye glasses for both eyes, in fine steel mounting, - - - - - -	2.25
928	Fig. 647, eye glasses for both eyes, in silver mounting, - - - - - - -	2.00
929	Fig. 648, eye glasses for both eyes, in gold plated mounting, - - - - - $5 to	7.00
930	Fig. 648, eye glasses for both eyes, in gold plated mounting, with spring, - $5 to	15.00
931	Fig. 647, eye glasses for both eyes, in solid gold, - - - - - - $6.50 to	10.00
932	Fig. 649, folding eye glasses, folding into pearl or shell cases, - - $3, $4, and	5.00
933	Fig. 650, reading glasses, horn mounted, $1, $1.50, and	2.00
934	Fig. 651, reading glasses in pearl and silver mounting, - - - - - - $8 to	10.00
935	Fig. 652, videscope, a large, magnificent lens, mounted with sliding tubes, clamp, &c., to screw to the table for reading, drawing, &c., - - - - - - $5 and	5.50
936	Fig. 653, goggles to guard the eye from wind and dust, - - - 75cts. to	1.25
937	Fig. 654, goggles, or eye protectors, of wire gauze, - - - - - $1 and	1.25
938	Fig. 655, goggles for squinting, - -	0.88
939	Fig. 656, " improved, -	1.50
940	*Fig. 657*, magnifiers, in black horn mounting,	[illegible]

941	Fig. 658, magnifiers, in black horn mounting, larger,	$ [illegible]
942	Fig. 659, " " for burning, &c.	[illegible]
943	Fig. 660, " bellows-shaped, 1 lens,	[illegible]
944	Fig. 660, " " 1 lens, larger,	[illegible]
945	Fig. 661, " " 2 " -	[illegible]
946	Fig. 661, " " 2 " larger,	[illegible]
947	Fig. 662, " " 3 " -	[illegible]
948	Fig. 662, " " 3 " larger,	[illegible]
949	Fig. 663, watch-maker's magnifier, in black horn, - - - - - - - -	[illegible]
950	Fig. 664, engraver's eye glass, in black horn, 62cts. and	[illegible]
951	Fig. 665, " in cocoa wood, large,	[illegible]
952	Fig. 665, " " extra,	[illegible]
953	Fig. 666, " with two lenses, in metal cases, $1.50 to	[illegible]
954	Fig. 666, " with two periscopic lenses, improved,	[illegible]
955	Fig. 667, hand magnifier, in metal rim and long handle, - - - - - -	[illegible]
956	Fig. 668, hand microscope, or doublet, with two lenses, - - - - - - - -	[illegible]
957	Fig. 669, " " larger, 75cts. and	[illegible]
958	Fig. 670, Stanhope lens, - - - - -	[illegible]
959	Fig. 671, linen and cloth prover, in wood box,	[illegible]
960	Fig. 671, " " brass, -	[illegible]
961	Fig. 672, " " " extra finish,	0.88
962	Fig. 673, " " with slide head,	1.00
963	Fig. 674, " " folding in brass,	0.75
964	Fig. 674, " " best finish "	1.25
965	Fig. 674, " " German silver,	1.50
966	Fig. 675, woollen provers, of large size, $1.50 to	2.00

TELESCOPES, &c.

967	Opera glasses, single, in plated or gilt mounting, - - - - - - - $1 to	2.00
968	*Opera glasses, single, extra, - - $4 to*	8.00

969	Fig. 675, opera glasses, double, for both eyes, ordinary, - - - - - -	$3 to	$ 4.00
970	Fig. 676, opera glasses, double, for both eyes, good quality, - - -	$3,50 to	5.00
971	Fig. 677, opera glasses, double, with superior achromatic lenses, in ivory mounting,	$6 to	12.00
972	Fig. 678, opera glasses, double, with superior achromatic lenses, in black mounting,	$7 to	15.00
973	Fig. 678, opera glasses, double, with superior achromatic lenses, in tortoise-shell mounting, - - - - - - -	$15 to	22.00
[illegible]	Fig. 679, Galilean telescopes, one draw, 50c., extra large, - - - - - - -		1.00
[illegible]	Fig. 679, Galilean telescopes, two draw, 75c., extra large, - - - - - - -		1.25
[illegible]	Fig. 680, Galilean telescopes, three draw, $1, extra large, - - - - - - -		1.50
977	Fig. 681, pocket achromatic telescopes, sixteen inch, three draw, - - - -	$5 to	6.00
978	Fig. 681, pocket achromatic telescopes, twenty-two inch, three draw, - - -		8.00
979	Fig. 681, pocket achromatic telescopes, thirty inch, three draw, - - - - - -		12.00
980	Fig. 682, pocket achromatic military telescopes, fifteen inch, six draw,	$7.50 to	10.00
981	Fig. 682, pocket achromatic military telescopes, twenty inch, six draw, - -		10.00
982	Fig. 682, pocket achromatic military telescopes, twenty-four inch, six draw,	$12 to	15.00
983	Fig. 682, pocket achromatic military telescopes, thirty inch, five draw, -	$14 to	16.00
984	Fig. 682, pocket achromatic military telescopes, thirty inch, four draw, -	$12 to	20.00
985	Fig. 683, ditto, ditto, the above with sun shade, extra, - - -	50 cts. to	1.50
986	Leather case for military telescopes,	$2 to	4.00
987	Fig. 685, achromatic ship telescope, best glasses, with one, two, or three, brass sliding tubes and sun shade, -	$9 and	10.00
988	Achromatic ship telescope, with leather body,	$11 to	13.00
989	Fig. 685, ship telescopes with common glasses,		7.00
990	Telescopes, extra large and extra power,	$22 to	25.00

LENSES, &c.

No.		
991	Fig. 686, plane glass, 1⅜ diameter, -	$ 0.12
992	Fig. 687, double convex lens, " -	0.38
993	Fig. 688, double concave " " 38cts. to	0.62
994	Fig. 689, plano-convex " " 50cts. to	0.62
995	Fig. 690, plano-concave " " 50cts. to	0.62
996	Fig. 691, meniscus " " -	0.50
997	Set of lenses for showing their form and properties; consisting of double convex, double concave, plano-convex, plano-concave, meniscus or concave-convex, and plain glass, all with ground edges, 1⅜ inch diameter, -	1.50
	Set of four first, 2 inches diameter, - -	3.50
	" 3 " - -	6.00
998	Cosmorama lenses, convex, 7 inch diameter,	2.50
999	" " 6 inch "	1.75
1000	" " 5 inch "	1.25
1001	" " 4 inch "	1.00
1002	" " 3 inch "	0.75
1003	Magic lantern lenses, the pair, 2 inch,	1.25
1004	" " 2½ inch,	1.75
1005	" " 3 inch,	4.00
1006	" " 3½ inch,	5.50
1007	" " 4 inch,	6.50
1008	Microscope lenses, double convex, one inch focus and upwards, ¾ inch diameter, -	0.38
1009	Microscope lenses, double convex, half inch focus, 50cts.; quarter inch focus, 63cts.; one eighth inch focus, - - - - -	0.88
1010	Microscope lenses, plano-convex, one inch, 50cts.; three quarter inch, 63cts; half-inch, 75cts.; quarter inch, - - -	0.88
1011	Microscope lenses, diameter, 1½ inches, 38cts. to	1.00
1012	Telescope lenses, for eye-glasses, 38cts. to	0.50
1013	" for object, 25cts. to	1.00
1014	" " superior, 6 ft. focus,	1.25
1015	" concave, for Gregorian eye-glass, - 38cts. to	0.50
1016	" achromatic, 18 inch, -	2.50
	to 42 inch, - -	25.00

No.			
1017	Daguerreotype lenses, from -	$1.25 to	$2.00
1018	“ achromatic,	$2 to	8.00
1019	Set of three lenses for compound microscope condenser, 1½ inch diameter, - -		1.25
1020	Set of two lenses for solar microscope condenser, 2 inch diameter,		1.12
1021	“ “ “ 2½ “		1.37
1022	“ “ “ 3 “		2.00
1023	“ “ for telescope, 6 ft. focus,		1.75
1024	Camera obscura lenses, 25cts.; and larger, to		1.50
1025	Fig. 692, model of double convex lens with converging rays, - - - - -		1.00
1026	Fig. 693, model of plano-convex lens with converging rays, - - - - -		1.00

MIRRORS.

1027	Magnifying	mirrors,	8	inches	diameter,	-	5.00
1028	“	“	6	“	“	-	1.75
1029	“	“	5	“	“	-	1.00
1030	“	“	4	“	“	-	0.63
1031	“	“	3	“	“	-	0.50
1032	Diminishing	“	6	“	“	-	2.00
1033	“	“	5	“	“	-	1.25
1034	“	“	4	“	“	-	0.88
1035	“	“	3	“	“	-	0.75
1036	Cylindrical	“	6	“	“	-	2.00
1037	“	“	5	“	“	-	1.50
1038	“	“	4	“	“	-	1.12
1039	Mirrors with nine faces, - - -					$2 to	3.00
1040	Grotesque mirrors, - - - -					$2 to	5.00

OPTICAL INSTRUMENTS.

1041	Fig. 694, model of the eye, - - -	5.00
1042	Fig. 695, image on the retina, - -	2.50

No.			
1043	Fig. 696, instrument for showing the nature of vision,		$ 6.00
1044	Fig. 697, muscles of the eye,		2.50
1045	Figs. 694 to 697, set of the above four instruments,		13.00
1046	Figs. 694, 696, and 697, set of the first, third, and fourth,		11.00
1047	Fig. 698, prisms, 37 cts., $1, $1.50, $2, and		3.00
1048	Fig. 698, prisms, mounted,	$2 to	5.00
1049	Compound prisms of three different kinds of glass, each having a different refractive power,		3.00
1050	Fig. 699, instrument for the recomposition of light,		1.00
1051	Fig. 700, glass box for experiments on refraction,	$4 and	5.50
1052	Fig. 701, optical diagonal machine, four inch,	$1.75 and	2.50
1053	Fig. 701, optical diagonal machine, five inch,	$2.25 and	2.50
1054	Fig. 701, optical diagonal machine, six inch,	$2.75 and	3.00
1055	Prints for diagonal machine, fourteen inch by twenty-two inch, per dozen,		1.00
1056	Fig. 702, portable camera obscura, $2.50,	$3.50, and	6.00
1057	Fig. 703, camera obscura for draughtsmen,		8.00
1058	Fig. 704, Daguerreotype apparatus, rosewood camera with German arrangement of achromatic lenses, mounted in brass tubes, with rack and pinion motion,		25.00
1059	Stand for camera,	$3 to	5.00
1060	Two coating boxes, per pair,		4.50
1061	Mercury box of cast iron, on foot,		1.50
1062	Plate vice, for holding the plates while cleaning,		1.75
1063	Buff sticks,		0.25
1064	Thermometer for mercury box,		0.38
1065	Glass spirit lamp,	20 cts. to	0.75
1066	Head rest to fasten to chair,		3.00
1067	*Daguerreotype* plates, medium size, $3 doz. quarter size,		4.50

No.		
1068	Fig. 706, camera lucida,	$8 to $12.00
1069	Fig. 707, graphic mirror,	$10 to 12.00
1070	Fig. 708, polemoscope,	5.00
1071	Multiplying glass,	50 cts. to 3.00
1072	Fig. 709, Claude Lorraine glass, with four to six glasses,	$1.50 to 3.00
1073	Claude black glass mirrors,	2.50

POLARIZATION OF LIGHT.

1074	Fig. 711, prism for double refraction, $2.50, $4, and	5.00
1075	Nichol's prism,	5.00
1076	Tourmaline plates,	$2 to 6.00
1077	Fig. 712, tourmaline polariscope,	$4 and 4.50
1078	Variety of crystals set in cork frames between glass plates, for preservation, used with the polariscope, each	0.75
1079	Figs. 717 to 722, selenite designs, in polished mahogany frames,	each $2.50 to 4.00
1080	Fig. 723, Biot's reflecting polariscope,	36.00
1081	Fig. 724, polariscope, with six selenite designs in case,	25.00
1082	Fig. 725, brass frame, for showing the transient polarizing structure communicated by pressure to a piece of annealed glass,	3.50
1083	Fig. 728, brass frame for showing the same by the unequal application of heat,	2.00
1084	Fig. 726, brass frame and glass plate for showing the same by bending,	5.00
1085	Fig. 729, five unannealed glasses for showing the tints of polarized light,	8.00
1086	Ten ditto,	15.00
1087	Two rectangular pieces of unannealed glass, which may be placed over or across each other, for showing the tints of polarized light,	2.50
1088	Savarre polarizing eye-piece,	8.00

MAGIC LANTERNS AND SLIDERS.

No.		
1089	Fig. 731, magic lantern, with oil lamp and reflector, and 12 slides, in mahogany frames and box, lens 2 inch diameter,	$ 5.50
1090	Fig. 731, “ 2½ “	8.00
1091	Fig. 731, “ 3¼ “	10.50
1092	German magic lantern slides with paper edges, 75cts., $1.00, and	1.50
1093	Fig. 732, phantasmagoria lanterns, lenses 4 to 4½ inch diameter,	15.00
1094	Fig. 733, improved phantasmagoria lanterns, lenses 3 inch diameter, with spring to hold sliders, brass adjusting tubes, and solar lamp,	14.00
1095	Fig. 733, “ lenses 3½ inch diameter,	15.00
1096	Fig. 733, “ “ 4 “	18.00
1097	Fig. 736, pair of improved lanterns for dissolving views,	50.00
1098	Magic lantern sliders, comic and amusing subjects, in great variety, sliders, 2¼ inch wide, 9 in. long, with 4 or 5 views, per doz.	4.50
1099	Ditto, sliders 3 in. wide, 12 in. long, per doz.	9.00
1100	“ 4 “ 15 “ 5 views,	15.00
1101	Fig. 737, movable comic sliders, representing a great variety of amusing changes, by drawing the loose slide, a few of which are enumerated, viz.	

Blooming of carnation pink,
“ rose,
Bleeding nun,
Death on the pale horse,
Chrysalis worm and butterfly,
Mount Vesuvius and eruption,
Tight-rope dancing,
Fencing,
Moss rose blooms, and exhibits Cupid,
Tailor and goose,
Boy and beer barrel,
Turk's head and eyes to move,
Blacksmith at work,
Tailor “
Barber “
Shoemaker “
Ship firing,
“ in storm,
Jim Crow,
Winter and summer,
Old man and death,
Dragon and movable wings,
Sailor and dance,
Trying to get through the world,

And a great variety of others, too numerous to mention.

Price, 3 in. wide, each, 83cts.; 4 in., $1.25.

No.		
1102	Dioramic sliders, beautiful views, with moving objects, shipping, &c. each, - -	$ 2.50
1103	Dioramic views of City Hall, Astor House, Trinity Church, Custom House, &c., with passengers, &c. - - - - - -	4.00

Set of astronomical sliders, 11 slides, three of which are movable, containing 32 diagrams, viz.

1 Rotundity of the earth (movable),
2 System of Ptolemy,
3 " Copernicus,
4 " Tycho Brahe,
5 " Newton,
6 Telescopic view of the Moon,
7 " " Jupiter,
8 " " Saturn,
9 Comparative sizes of the planets,
10 Comparative distances of the planets,
11 Orbit of a comet,
12 Comet of 1811,
13 Signs of the zodiac,
14 Inclination of the planets' orbits,
15 Direct and retrograde motion,
16 The seasons,
17 Phases of the moon,
18 The earth's shadow,
19 Ditto,
20 Ditto,
21 Cause of the moon's eclipse,
22 Cause of the sun's eclipse,
23 Inclination of the moon's orbit,
24 Eclipse of sun (movable),
25 " moon "
26 Spring tide at new moon,
27 " at full moon,
28 Neap tide,
29 The constellation Ursa Major,
30 The constellation Orion,
31 Portion of the milky way,
32 Various nebulæ,

1104	Fig. 740, 3 sizes,	9 in. long,	2¼ in. wide,	$ 7.50
1105	Fig. 740,	12 "	3 "	15.00
1106	Fig. 740, largest	15 "	4 "	20.00

MOVABLE ASTRONOMICAL DIAGRAMS,

THE MOTION PRODUCED BY RACK-WORK.

No.		
1107	No. 1, the solar system, showing the revolution of all the planets with their satellites round the sun,	$ 5.75
1108	No. 2, the earth's annual motion round the sun, showing the parallelism of its axis, thereby producing the seasons,	5.00
1109	No. 3, this diagram illustrates the cause of spring and neap tides, and shows the moon's phases, during its revolution,	4.25
1110	No. 4, this diagram illustrates the apparent direct and retrograde motion of Venus or Mercury, and also its stationary appearance,	4.00
1111	No. 5, a diagram to prove the earth's rotundity,	3.75
1112	No. 6, this diagram illustrates the eccentric revolution of a comet round the sun, and shows the appearance of its tail at different points of its orbit,	5.25
1113	No. 7, The diurnal motion of the earth, showing the rising and setting of the sun, illustrating the cause of day and night, by the earth's rotation upon its own axis.	4.00
1114	No. 8, this diagram illustrates the annual motion of the earth round the sun, with the monthly lunations of the moon.	5.75
1115	No. 9, this diagram shows the various eclipses of the sun with the transit of Venus,	4.00
1116	Or the whole set in a box with lock and key,	38.00
1117	Constellations in six sliders; their situation with regard to the north pole is denoted by an arrow.	
	Slider No. 1.—1, Aries; 2, Taurus; 3, Gemini; 4, Cancer.	
	Slider No. 2.—5, Leo; 6, Virgo; 7, Libra; 8, Scorpio.	

No.		
	Slider No. 3.—9, Sagittarius ; 10, Capricornus ; 11, Aquarius ; 12, Pisces. Slider No. 4.—13, Draco and Ursa Minor ; 14, Cepheus and Cassiopeia ; 15, Andromeda and Triangula ; 16, Auriga. Slider No. 5.—17, Perseus and Caput Medusæ ; 18, Bootes and Canes Venatici ; 19, Hercules and Cerberus ; 20, Cygnus and Lyra. Slider No. 6.—21, Antinous and Aquila ; 22, Ophiuchus and Serpens ; 23, Canis Major and Minor ; 24, Cetus.	$ 12.00
1118	Set of five slides, illustrating water spouts, from Dr. Lardner's lectures, the set,	10.00
1119	Set of six slides, illustrating auroras, from Dr. Lardner's lectures, the set,	12.00
1120	Fig. 741, natural history sliders, in sets of twelve slides, three sizes ;— 9 inches long, 2¼ wide, containing 36 views,	5.00
1121	12 " 3 " " 36 "	12.50
1122	15 " 4 " " 60 "	20.00
1123	Figs. 741 and 742, set of natural history sliders, in fifty-six slides, and over 200 diagrams, of which twenty-four sliders are mammalia, seven birds, four amphibia, five fishes, eight insects, eight worms, with book explaining the whole,	100.00
1124	Separate sliders, each,	2.00
1125	Fig. 743, costumes of all nations, in twelve sliders, forty-eight views large size,	20.00
1126	Fig. 743, modern costumes of nations, fifty-six sliders, containing above 290 figures—viz. 4 England, 3 France, 5 Austria, 1 Iceland, 4 Russia, Greenland, and Lapland, 3 Turkey, 4 Tartary and Circassia, 4 China, 3 Persia and Arabia, 3 Empire of Cabul, 1 Birman Empire, 5 Hindostan, 2 Greece, 3 Java and Asiatic Islands, 3 Egypt and Abyssinia, 4 Tripoli and North Africa, 4 South Sea Islands and northwest coast of America,	100.00

No.		
1127	Ancient Costumes in six sliders, and twenty-five figures, - - - - - -	$ 12.00
1128	Fig. 744, Scripture history sliders, in twelve slides, viz.:— Slider No. 1.—Adam and Eve driven out of Paradise, Gen. c. 3, v. 24; Hagar and Ishmael, Gen. c. 21, v. 14; Isaac blessing Jacob, Gen. c. 27, v. 23. Slider No. 2.—Joseph sold into Egypt, Gen. c. 37, v. 28; Joseph meeting his father, Gen. c. 50, v. 1; the finding of Moses, Exod. c. 2, v. 5. Slider No. 3.—The ark of the covenant, Exod. c. 25, v. 10; the dress of the high priest, Exod. c. 28, v. 2; the altar of incense, Exod. c. 30, v. 1. Slider No. 4.—The altar of burnt offering, Exod. c. 27, v. 1; an Aaronite or scribe, Exod. c. 28, v. 40; the golden candlestick, Exod. c. 25, v. 31. Slider No. 5.—Return of the spies, Num. c. 13, v. 23; the brazen serpent, Num. c. 21, v. 9; Balaam and his ass, Num. c. 22, v. 22. Slider No. 6.—Samson and the lion, Judges c. 14, v. 6; presentation of Samuel, 1st Sam. c. 1, v. 28; Samuel in the temple, 1st Sam. c. 3, v. 10; Elijah fed by ravens, 1st Kings, c. 17, v 6. Slider No. 7.—David and Goliath, 1st Sam. c. 17, v. 51; David dancing before the ark, 2d Sam. c. 6, v. 14; Nathan reproving David, 2d Sam. c. 12, v. 7. Slider No. 8.—The annunciation, Luke, c. 1, v. 28; the birth of Christ, Luke, c. 2, v. 16; Christ brought to the temple, Luke, c. 2, v. 22. Slider No. 9.—The flight into Egypt, Matt. c. 2, v. 13; the holy family, Mark, c. 1; Christ and the woman of Samaria, John, c. 4, v. 7.	

Slider No. 10.—Christ stilling the tempest, Matt. c. 8, v. 24; the good Samaritan, Luke, c. 10, v. 30; the lord of the vineyard and laborer, Matt. c. 20, v. 12.

Slider No. 11.—The return of the prodigal son, Luke, c. 15, v. 20; trial of Peter's faith, Matt. c. 14, v. 29; Herodias with the head of John the Baptist, Mark, c. 6, v. 28.

Slider No. 12.—The crucifixion, John, c. 19, v. 30; the women at the sepulchre, Mark c. 16, v. 5; the resurrection, Matt. c. 28, v. 9; the disciples at Emmaus, Luke, c. 24, v. 31. $ 32.00

129 Fig. 744, Set of Scripture sliders, in 14 slides, two of which are movable, viz:—

1, Milton's council, spirit moving on the waters, creation of sun, creation of moon and stars.

2, Adam and Eve in Paradise, Adam and Eve driven from Paradise, Cain slaying Abel, flood.

3, Tower of Babel, flight of Lot from Sodom, Abraham offering Isaac, Jacob's vision.

4, Moses found in the bulrushes, Moses and the burning bush, Moses receiving the Law, spies with the grapes of Eschol.

5, Samson slaying the lion, Samson and the carcase, Samson and gates of Gaza, Samson and death.

6, David playing the harp before Saul, judgment of Solomon, Job and his comforters, Daniel in lions' den.

7, New Testament, annunciation to Mary, birth of our Saviour, shepherds and angels praising God.

8, Flight into Egypt, baptism of our Saviour, miraculous draught of fishes, Nicodemus and Christ at night.

9, Christ at the well and Samaritan woman, Christ in the ship in a storm, Christ healing the sick, Christ raising the dead.

No.		
	10, Christ blessing little children, Christ giving sight to the blind, Christ's Transfiguration, Christ's entry into Jerusalem.	
	11, Judas betraying with a kiss, Pilate washing his hands, Jesus scourged, Jesus crowned with thorns.	
	12, Jesus bearing his cross, crucifixion, ascension, end.	
	13, movable, Israelites crossing the Red Sea, with the overthrow of the Egyptian host.	
	14, movable, Ark, with Noah, his family, and the animals entering. The set,	$ 36.00
1130	Set twelve Scripture history sliders, thirty-six figures,	24.00
1131	Noah, his family, and animals entering the ark, movable,	3.25
1132	Israelites crossing the Red Sea with the Egyptians pursuing, movable,	3.25
1133	Single views on Scripture subjects,	0.88
1134	Splendid views in the Holy Land, and select Scripture subjects, viz. Jerusalem, Bethlehem, Nazareth, Bethany, Damascus, Nineveh, Tiberius, Antioch, Patmos, Fords of Jordan, Seven Churches of Asia, ruins of Tyre, with many others of a similar character, each, from $3.50 to	5.50
1135	Views of the progress of intemperance in the drunkard's stomach, nine slides,	18.00
1136	Views of progress of intemperance; 1, invitation to drink; 2, sickness and repentance; 3, relapse; 4, expecting wife; 5, ruined family; 6, robber,	18.00
1137	Set of twenty sliders on intemperance,	25.00
1138	Cromatrope sliders, producing a variety of most brilliant revolutions and changes, produced by means of two revolving wheels of painted glass turning in opposite directions while in the lantern, a variety of patterns, paintings three and three and a half inch diameter, $5 to	6.50
1139	Rack cromatrope slides, $6 to	7.50
1140	View of the muscles of the head and face,	5.00

No.		
1141	View of the nerves of the head and face,	$5.00
1142	" heart and lungs,	5.00
1143	" skull,	3.50
1144	" ear,	3.00
1145	" neck,	3.00
1146	" skin,	2.00
1147	" bones of the hand and foot,	3.50
1148	Various slides giving motion to ships, animals, &c.	$2.50 to 3.50
1149	Fig. 745, botanical sliders, representing 48 flowers, 12 slides,	20.00
1150	Fig. 745, " 12 in. long; 3 in. wide,	14.00
1151	Botanical sliders, in 14 slides, or 50 views, illustrating botany, from germination of seeds, to the most beautiful flowers, trees, &c., with book explaining the whole,	34.00

Slider 1.—1, cellular tissue; 2, cellular ducts; 3, woody fibre; 4, spiral vessels.

Slider 2.—5, spiral vessels in leaf; 6, vascular ducts; 7, forms of roots; 8, forms of stem.

Slider 3.—9, section of exogenous stem; 10, section of sassafras wood; 11, sections of endogenous stem.

Slider 4.—12, fern stem; 13, forms of leaves; 14, leaf of gleditsia; 15, pitchers of Nepenthes, &c.

Slider 5.—16, pitcher of Dischidia; cuticle and stomata; 18, section of apple leaf; 19, section of oleander leaf.

Slider 6.—20, forms of stamens; 21, structure of pistil; 22, monstrous carpels; 23, structure of seed vessel.

Slider 7.—24, process of fertilization; 25, germination of seed; 26, algæ (sea-weeds); 27, lichen, Iceland moss.

Slider 8.—28, fungus, amanita; 29, rafflesia arnoldi; 30, chara flexis; 31, moss, bryum cæspiticum.

Slider 9.—32, tree fern; 33, endogens, saccharum officinale (sugar cane); 34, phœnix dactylifera (date palm); 35, colchicum autumnale (meadow saffron).

No.		
	Slider 10.—36, Zingiber officinale (ginger plant); 37, exogens, zamia horrida; 38, atropa belladonna (deadly nightshade).	
	Slider 11.—39, linaria communis (snapdragon); 40, convolvulus major; 41, ericæ (heaths).	
	Slider 12.—42, anthemis pyrethrum (pellitory); 43, tamarindus indica (tamarind); 44, camellia japonica.	
	Slider 13.—45, passiflora magniflora (grenadilla); 46, cardamine pratensis (lady's smock); 47, ficus carica (Fig).	
	Slider 14.—48, cactus speciosissima; 49, ligusticum scoticum; 50, myristica moschata (nutmeg).	
1152	**Set of kings and queens of England, from William the Conqueror to Queen Victoria, 9 sliders, 37 portraits, - - - -**	**$ 18.00**
1153	**Set of four views of public buildings, viz.** 1. St. Paul's, London; Pavilion at Brighton; Southwark Bridge, London. 2. Westminster Abbey; Falls of Niagara; Waterloo Bridge, London. 3. St. Peter's Church at Rome; Fingal's Cave; Parthenon at Paris. 4. Mount St. Michael, Cornwall; Military Hospital, Paris; Island of Staffa. With description, - - - price	10.00
1154	Set of select humorous subjects, in twelve sliders, with description, - - -	24.00
1155	Set of History of France, in 42 sliders, having three or four views on each, - -	25.00
	All the sliders are of full size, four inches wide, where not otherwise specified.	

MICROSCOPES.

No.		
1156	Fig. 746, flower microscope with one lens and point,	$ 1.12
1157	Fig. 746, ditto, two lenses and forceps,	1.50
1158	Fig. 747, insect microscope with two lenses small size,	1.00
1159	Fig. 747, ditto, large size,	1.25
1160	Fig. 748, universal single microscope, in mahogany case,	3.50
1161	Fig. 748, ditto, with mirror,	4.50
1162	Fig. 749, compound and single microscope,	9.00
1163	Fig. 750, improved compound and single microscope with rack adjustment,	15.00
1164	Fig. 751, compound microscope,	10.00
1165	Fig. 751, ditto, with one power only, and smaller size,	4.00
1166	Fig. 752, large compound microscope, with rack adjustment,	20.00
1167	Fig. 753, Culpepper's microscope.	$15 to 25.00
1168	Fig. 754, Gould's compound and single microscope,	12.00
1169	Improved compound and single microscope, mounted on folding legs, pillar, and joint,	$38 to 42.00
1170	Achromatic microscope, with three powers,	20.00
1171	Fig. 755, achromatic microscope, with five powers,	70.00
1172	Fig. 756, improved achromatic microscope,	$130 to 150.00
1173	Fig. 757, solar microscope, with three inch condensing lens, in brass mounting, with three rack motions,	50.00
1174	Ditto, with five inch condenser,	75.00
1175	Ditto, with three inch condenser, and one rack motion,	42.00
1176	Ditto, with three inch condenser, and common mounting,	25.00
1177	Ditto, with two inch condenser, and three rack motions, framework all of brass,	40.00

No.		
1178	Solar microscope with two inch condenser, and one rack motion,	$ 35.00
1179	Fig. 758, solar microscope, for opaque and transparent objects.	$60 to 100.00
1180	Fig. 759, oxyhydrogen microscopes,	$80 to 150.00
1181	Fig. 760, set of 6 ivory sliders, each containing four objects for the microscope,	3.00

MISCELLANEOUS.

1182	Fig. 761, numeral frame with 144 balls,	0.88
1183	Figs. 762 to 773, set of twelve geometrical solids,	1.25
1184	Set of thirty geometrical figures in neat rosewood case,	6.00
1185	Fig. 774, dissected cone,	$1,25 to 2.00
1186	Set of sixty-four one inch cubes,	1.25
1187	Set of 144 specimens of minerals, arranged and labelled in three trays, and mahogany box with lock,	12.00
1188 & 9	Fig. 775 to 779, ear trumpets,	$1 to 1.25
1190	Fig. 780, ear trumpet with flexible tube,	2.25
1191	Fig. 781, breast pump,	5.00
1192	Figs. 781 and 782, breast pump with cupping apparatus, three cups,	9.00
1193	Breast and cupping apparatus, with scarificator,	15.00
1194	Lacquer for brass, per bottle,	0.25
1195	White varnish for silvered articles, clock dials, &c.,	0.25
1196	Preparation for silvering thermometers, clock dials, &c., per ounce,	0.12
1197	Diamonds for cutting glass,	$3 to 5.00
1198	Platina wire, per ounce, $10 ; per dwt.,	0.75
1199	“ foil, “ “ $10 ; “ “	0.75
1200	Spongy platina, arranged for hydrogen lamps,	0.38